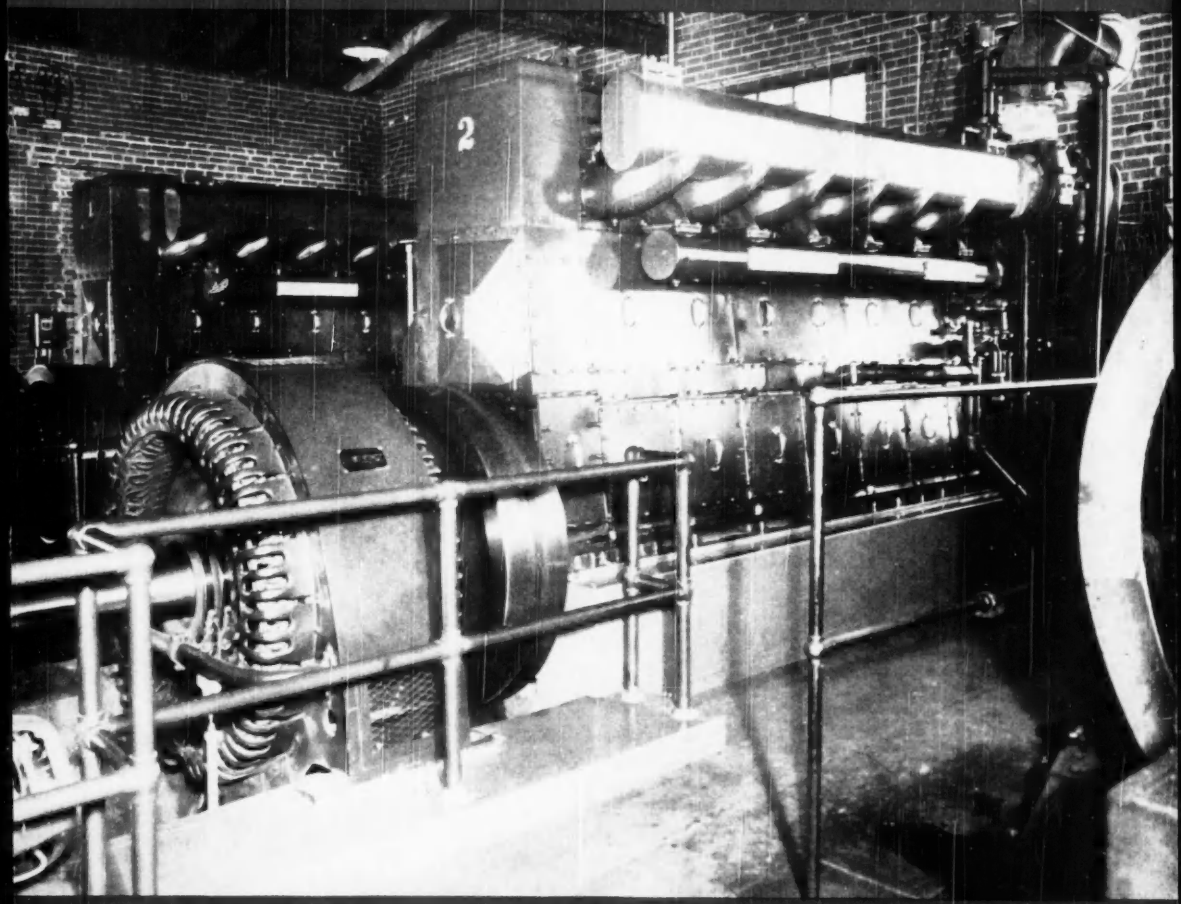
Diesel Power

& Diesel Transportation

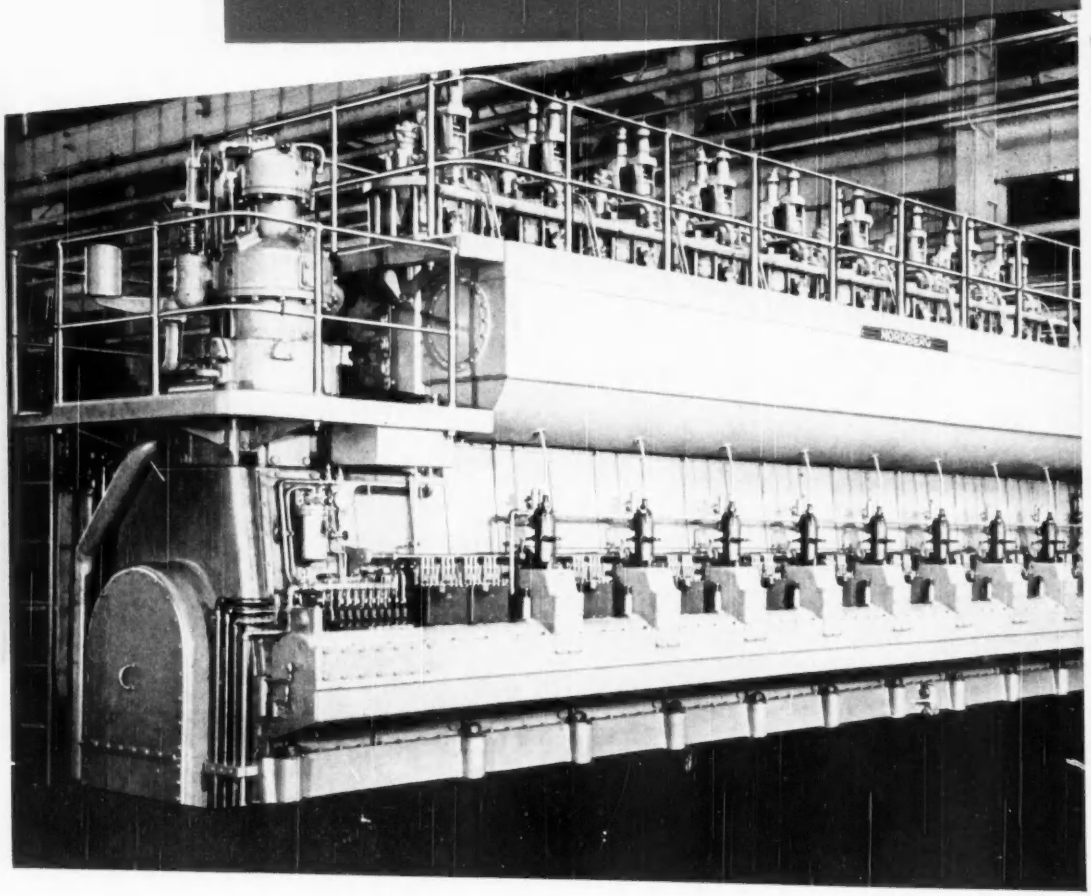


Our 28th Year

Give

MARCH, 1950

EFFECTIVE REDUCES 2



TUNE IN . . . TEXACO presents MILTON BERLE on television every Tuesday night. METROPOLITAN OPERA radio broadcasts every Saturday afternoon.

TEXACO

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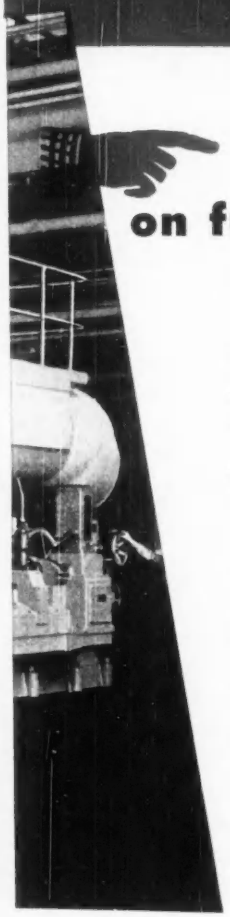
LUBRICATION VITAL EXPENSES



Use Texaco Ursa Oils and save on fuel consumption and upkeep costs

When you lubricate your Diesels with* Texaco Ursa Oils *you can be sure of —

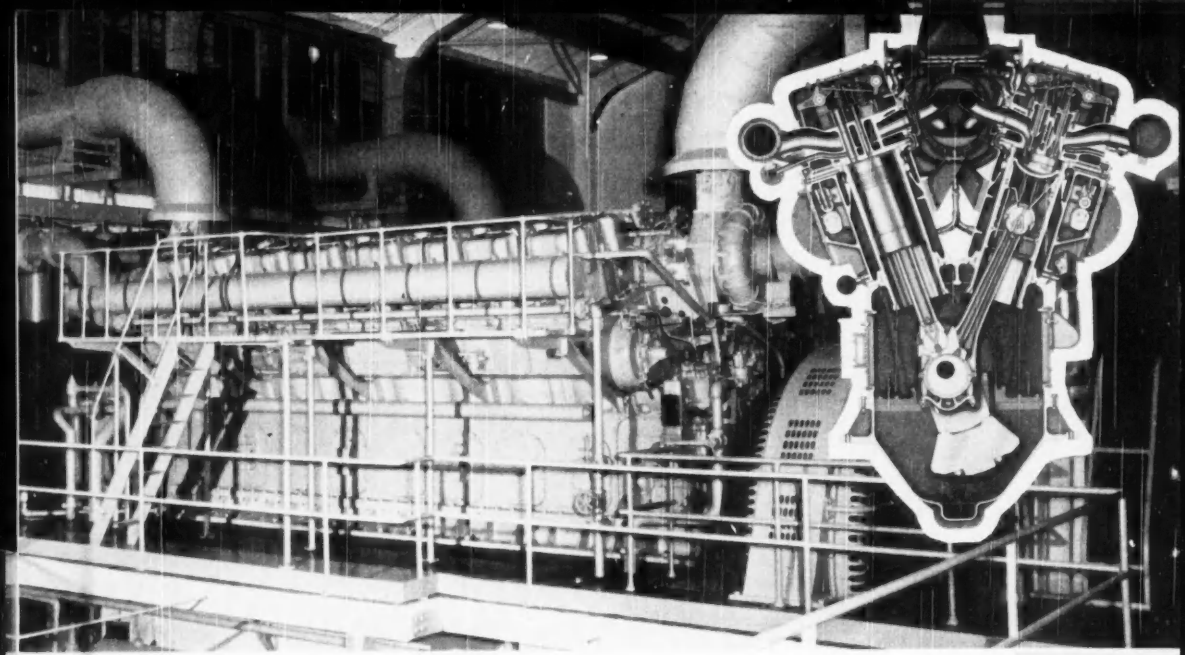
- free rings
- better compression and combustion
- freedom from harmful carbon, sludge, varnish
- longer life for bearings and all moving parts

You get these benefits because *Texaco Ursa Oils* are especially made for Diesel lubrication, have exceptional resistance to oxidation, exceptional ability to stand up under high temperature and pressure. Dollar-wise, they assure you the trouble-free, full power performance that means savings in fuel consumption and reduction in maintenance costs.

There is a complete line of *Texaco Ursa Oils*. They are approved by leading Diesel manufacturers and — *more stationary Diesel h. p. in the U. S. is lubricated with Texaco Ursa Oils than with any other brand!*

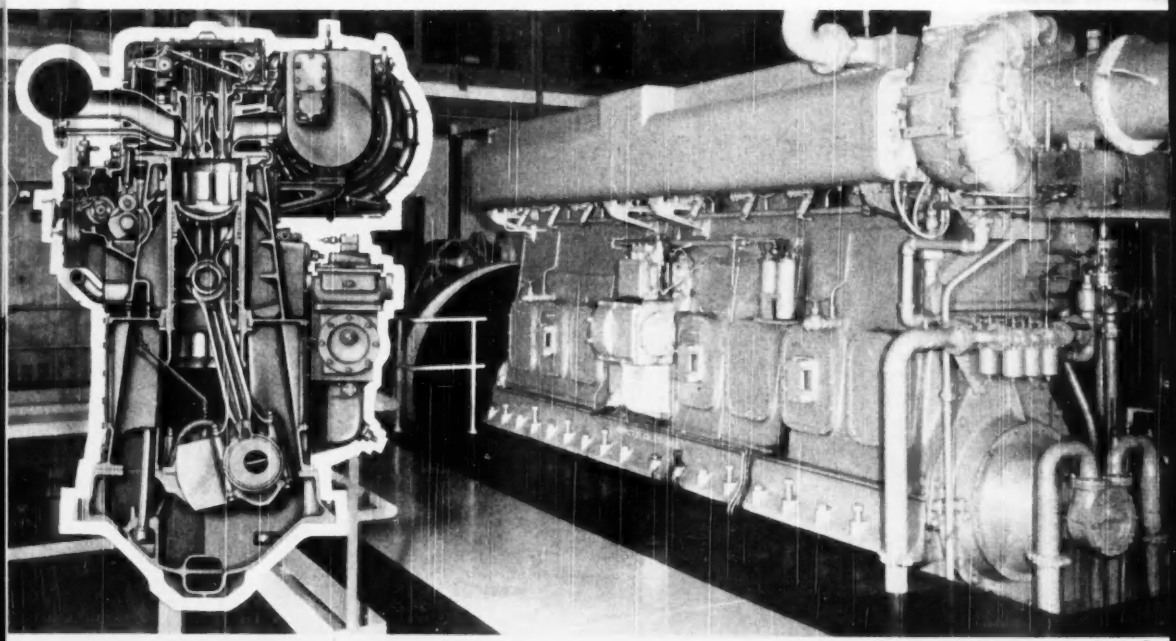
Step up your Diesel efficiency and step down your costs. A Texaco Lubrication Engineer will gladly help you. Just call the nearest of the more than 2,000 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, New York.

URSA OILS FOR ALL DIESEL ENGINES



ABOVE: *Cooper-Bessemer supercharged LSV-16 gas-diesel in Arizona-Edison's new Yuma plant.* INSERT: *Cross section of the Cooper-Bessemer LS V-type engine showing rugged, compact construction, articulated connecting rods and counterbalanced crankshaft.*

BELOW: *LS in-line gas-diesel likewise installed in the new Yuma plant. This and above engine are both convertible on short notice to spark-ignited 100% gas-fueled operation.* INSERT: *Cross section of the Cooper-Bessemer LS in-line engine which has a long-established reputation for reliability and low maintenance.*



GAS · DIESEL · GAS-DIESEL ENGINES

New York Washington Bradford, Pa. Parkersburg, W. Va. San Francisco, Cal. Seattle, Wash.

Another Example of Efficient Power at Lower Cost

VERSATILITY · COMPACTNESS · EFFICIENCY

for biggest savings ever!

WITH COOPER-BESSEMER TYPE LS ENGINES

You are probably aware that Cooper-Bessemer has been in the news several times over the past few years. One reason for this was the introduction of new engines and developments which brought about startling reductions in the cost of producing power.

1. TWO DESIGNS . . . LS engines are now available in both "V" and in-line design, atmospheric or supercharged, offering a range of 6 to 16 cylinder sizes rated 825 to 3400 bhp. "V" design doubles the horsepower with virtually no increase in space, obviously permitting great economies in installation, housing, maintenance and operation where units of 290 to 3400 hp are applicable.

2. TRI-FUEL CONVERSION . . . A very recent development now provides for 1 to 3-hour conversion from the full diesel (or gas-diesel) cycle to *spark-ignited gas operation*, with few changes and no replacement of major parts. Thus the LS engines can be operated on 100% oil, 100% gas or any combination of oil and gas, at will, as influenced by fuel availability.

3. FULL-RANGE GAS-DIESEL ECONOMY . . . The Cooper-Bessemer gas-diesel (dual-fuel) principle is distinguished not only for high thermal efficiencies at full load, but for efficiencies at *any fractional load* greatly exceeding the best performance of all ordinary gas engines, gas-diesels and oil diesels.

4. SUPERCHARGING . . . Not only are the Type LS oil and gas-diesel engines available supercharged, but a recent, revolutionary Cooper-Bessemer development carries supercharging into spark-ignited gas engine operation. This easily permits a 30% saving in fuel and 80% more horsepower. Thus all the advantages of supercharging are available *regardless* of the fuel or fuel combination used.

Perhaps this review of developments pertaining to the LS engines will give you some money-saving ideas. The nearest Cooper-Bessemer office will of course be glad to give you further, more detailed data.

by **Cooper-Bessemer**

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

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Announcing a New Piston Ring Material

"CYCLAN"

Especially developed for severe service in high duty diesel and gas engines. This superior material has the following necessary qualifications of a good piston ring alloy!

- ✓ En Value higher than 20,000,000.
- ✓ *Tensile Strength* in excess of 60,000 P. S. I.
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- ✓ *High Resistance to Breakage* and the ability to undergo considerable distortion prior to fracture without sacrificing resilience.
- ✓ A Structure that assures excellent wear qualities.

Write for additional information.

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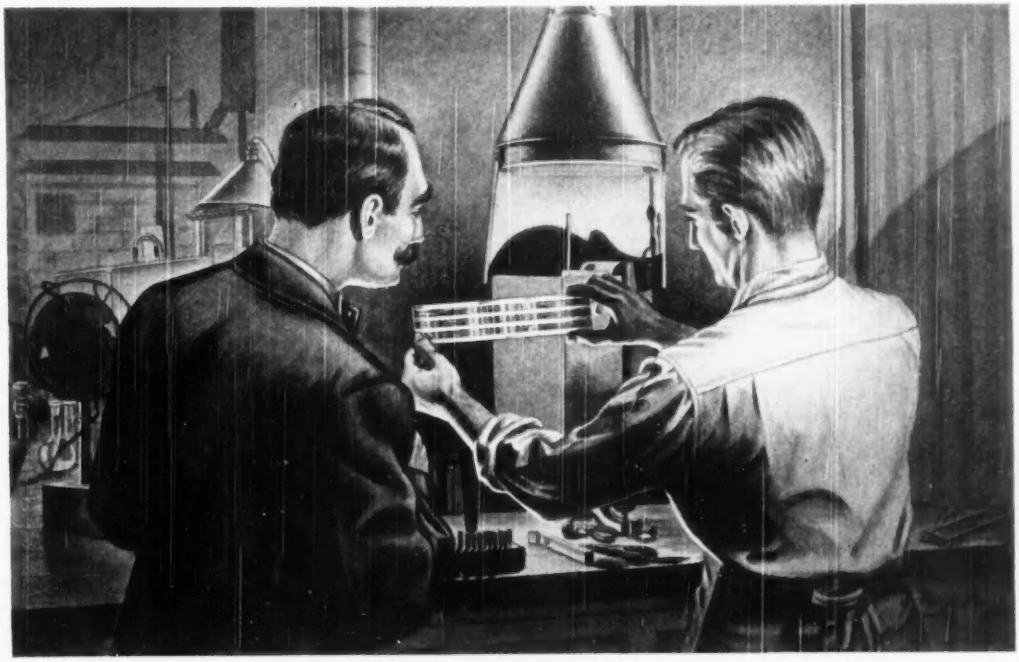
PISTON RINGS · PISTONS
CYLINDER SLEEVES



Look at this Exide spectrogram, Mr. Diesel

See how accurately . . . and to what minute degree . . . every element in the lead is measured.

What and *how much* are important to know. For a very small percentage of certain elements can affect battery performance and life.

Yet spectrum analysis is but one example of the great care taken by Exide to produce a battery with the mighty cranking power that Diesel starting demands.

Exide Batteries have that power. Test after test proves it. Especially the final performance tests, which are tough, rugged, brutal . . . much more severe than the battery will have to meet in service.

Exide Diesel Cranking Batteries pass those tests with credits to spare. That's why you can count on Exides for a quick breakaway and a high cranking speed.

It's also the reason why so many makers and users of Diesel engines choose Exide Batteries . . . why these batteries are best for you.

THE ELECTRIC STORAGE BATTERY COMPANY
Philadelphia 32
Exide Batteries of Canada, Limited, Toronto

DEVELOPMENT WORK NEVER CEASES in improving the performance of Exide Batteries. Our staff of engineers, chemists, metallurgists, physicists and technicians is the largest in the battery industry.

"Exide" Reg. U.S. Pat. Off.

1888 . . . DEPENDABLE BATTERIES FOR 62 YEARS . . . 1950

We Make Sure Before We Start

Here at Harrison, we have everything it takes to engineer and produce heat transfer units to meet the specific requirements of any Diesel application.

We have *design experience,* gained by correlating field results with laboratory test data covering both performance and structural strength.

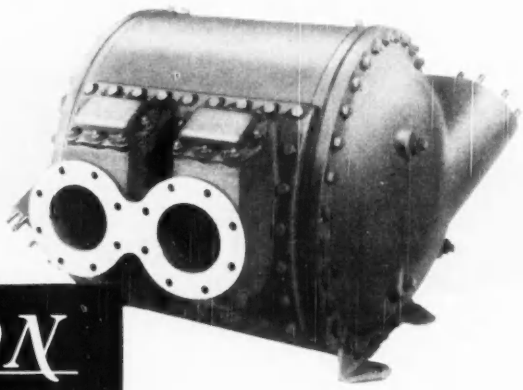
We have *sample-making* and *testing equipment* from which we can obtain full basic evaluation of any particular type of heat transfer unit, and determine its ability to meet rigorous field conditions.

We have ample *manufacturing facilities* for quality and quantity production at low cost.

We have a well organized *service group* to aid our customers in obtaining a broad and economical use of our products.

Manufacturers of Diesel engines are invited to avail themselves of our experience and facilities in seeking the solution of their cooling problems.

HARRISON HEAT TRANSFER UNITS



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FLEXIBILITY & DURABILITY FOR CONVEYING . . . provides strength; withstands severest abrasion
HANDLES HOT MATERIALS . . . unsurpassed for air, naphtha, kerosene, chemicals and volatiles
TAMES A POWER THROB . . . eliminates vibration or diesel exhaust . . . smoother power, cooler operation.
TAKES SHAKES OUT OF AIR LINES . . . on compressor, diesel exhausts and steam lines
ARMED SECURITY FOR CABLES . . . flexible protective covering to protect cables, instrument wires and lines

TORTURE-TESTED FOR SERVICE . . . PERFORMANCE-PROVED FLEXIBILITY—IT'S PENFLEX FOR LONG WEAR . . . EVERYWHERE

Whether it's on a diesel exhaust . . . a conveyor tube . . . or on air lines, Penflex tubing has proved itself in the power industry. Rugged . . . tough . . . and flexible, Penflex tubing is made to stand the most severe usage with the least wear.

From ⅛" I.D. to 30" I.D. . . . bronze, galvanized or stainless steel, Penflex makes all types and sizes of flexible tubing and metal hose. And Penflex "Flexineering"—the science of applying flexible tubing to fit the particular need of the power industry—assures the right tube for each installation. When you require tubing or hose that is tight as a pipe, but flexible . . . safe at high temperatures . . . and free from metal fatigue, specify Penflex.

Penflex manufactures a complete line of four wall interlocked and seamless welded corrugated flexible tubing . . . plus automatic barrel fillers, rivet passers, accessories and fittings. To cut your "break-even point," write for your copy of "Flexineering At Work."

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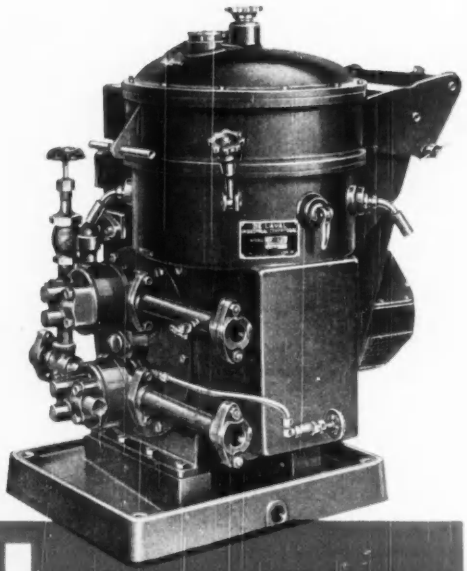
I STOP TROUBLE before it STARTS!

"I am De Laval Centrifugal Force. I am expert at removing dirt from Diesel lubricating oil. If any water is present in the oil, I get rid of that, too. Because I give double-barreled protection to the engine, I ***stop*** trouble before it starts."

De Laval centrifugal force does its job ***thoroughly***. Dirt is stored in the bowl, outside the zone where purification takes place. Water is continuously discharged after being thrown out of the oil.

The De Laval "Puri-Filter" goes one step further and removes colloidal carbon as well — the ultimate in Diesel lubricating oil maintenance.

When used to purify Diesel fuel oil, De Laval centrifugal force enables the engineer to get maximum BTU value from the oil. Clean fuel oil means freedom from excessive abrasion and wear on cylinder linings and piston rings.



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THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

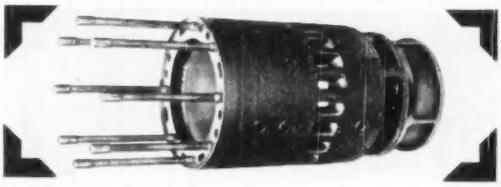
De Laval OIL PURIFIERS

STANDARD ENGINEER'S REPORT

DATA

LUBRICANT	RPM Delo Oil R.R.
UNIT	Locomotive Diesel G.M. 567B
TRAIN	"California Zephyr"
SERVICE	San Francisco-Salt Lake
FIRM	Western Pacific R.R. Co.

Only 0.002 inch cylinder wear in ½ million miles!

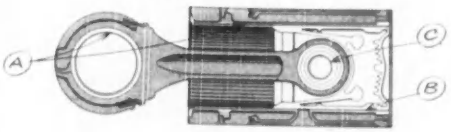


515,720 MILES WITHOUT REPLACEMENT of a single part was the record for all 48-cylinder assemblies in a "California Zephyr" diesel locomotive when this one was pulled for inspection. Lubricated with specially compounded RPM DELO Oil R. R., the engines stay in continuous service a full million miles without time off for overhaul!

"THE CALIFORNIA ZEPHYR," new streamliner with Vista-Dome cars, runs daily both ways across the continent. Only 3 diesel locomotives keep it on schedule between San Francisco and Salt Lake.

NO RING TROUBLE or lacquer deposit problems have been encountered in this long service, as this unretouched photo of the piston indicates. The cylinder "miked" only 0.002 inch taper and 0.005 inch out of round.

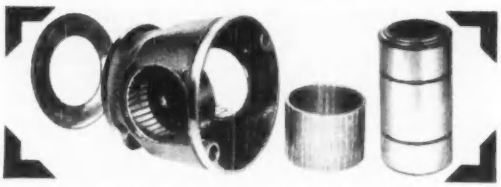
How RPM DELO Oil R. R. prevents wear, corrosion, oxidation



A. Special additive provides metal-adhesion qualities . . . keeps oil on parts whether hot or cold, running or idle.

B. Anti-oxident resists deterioration of oil and formation of lacquer . . . prevents ring-sticking. Detergent keeps parts clean . . . helps prevent scuffing of cylinder walls.

C. Special compounds stop corrosion of any bushing or bearing metals and foaming in crankcase.



WRISTPIN BUSHING IN PERFECT CONDITION! Measurement proved the bushing was still "standard" after the more than ½ million miles of service! RPM DELO Oil R. R. will not corrode silver bushings. All parts were put back in service.

RPM DELO LUBRICATING OILS

Trademark RPM DELO Reg. U.S. Pat. Off.

FOR MORE INFORMATION about this or other petroleum products, or the name of your nearest distributor, write or call any of the companies listed below.

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THE CALIFORNIA OIL COMPANY • Barber, N.J., Chicago, New Orleans
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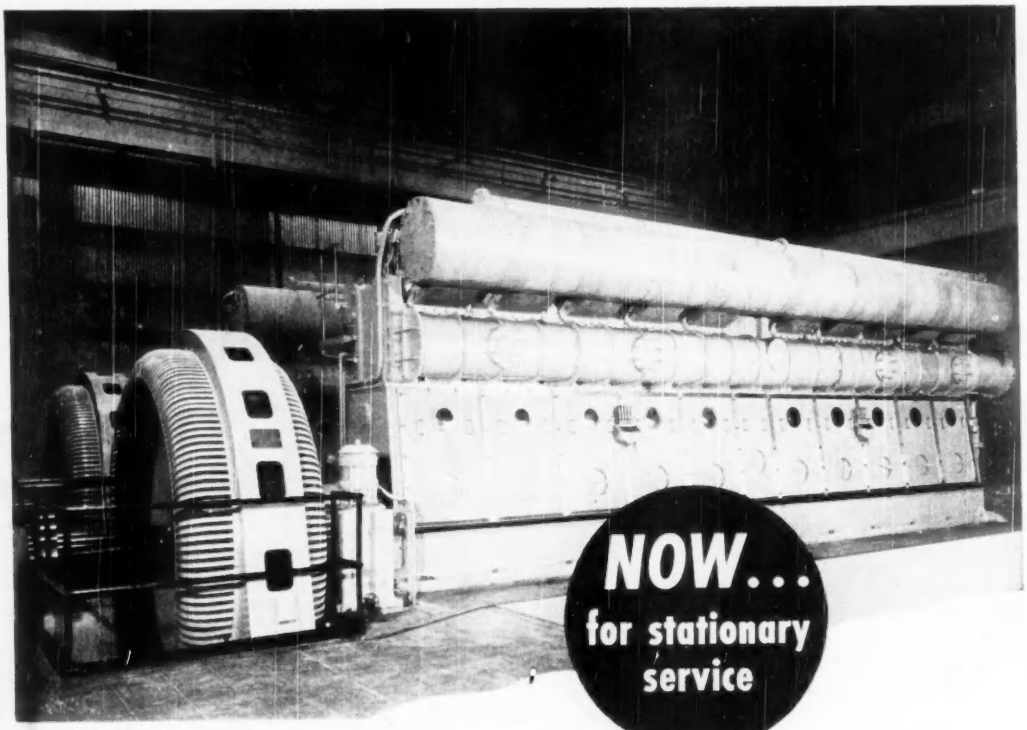

38% more horsepower per cylinder

from the Hamilton 21½" x 27½"

These are the principal changes that have been incorporated during the last year in the Hamilton 21½" x 27½":

Rotary Exhaust Valves

Rotary valves in the exhaust outlets, which close while intake ports are closing, entrap a larger volume of air, at slightly higher than atmospheric pressure. Total increase in air at full load available for burning more fuel—is approximately 40%.

Larger Clearance Volume

By enlarging the combustion chamber and changing the shape of piston and head, better scavenging results and no increase in compression pressures even with the greater volume of air.

Intercooling of Scavenging Air

A scavenging-air cooler is installed between the blower and intake ports. This lowers the temperature of the entire cycle, permits development of more horsepower without increase in temperatures.

Automatic Air Control

Also, an automatic scavenging-air-volume control is provided to reduce flow at partial loads. This assures quiet, clean, performance and has been a major factor in the good efficiency of this engine at reduced loads.

The Hamilton Series 21-8A diesel, a 2-cycle engine with 21½-inch bore and 27½-inch stroke, has been redesigned in the last year so that it is now rated for 60-cycle generating sets, at 520 hp per cylinder, 277 rpm. This is the *net* power developed at 100% load—the power available at the shaft after allowing for blower requirements.

This rating represents a 38% increase in horsepower. It has been achieved with no increase in compression or firing pressures, and practically no increase in temperature. B.m.e.p. is held to the very conservative value of 74.5 lb per sq. in. Speed is well within the limits of good practice. Fuel guarantee is low—and is practically the same for all loads between 50% and 100%—which, we believe, gives this engine the lowest guaranteed fuel rate, for average loads, of any diesel in its horsepower range.

If you are considering a diesel in the 2600-hp range and up, we would be pleased to give you full information on this engine. Call the Lima-Hamilton sales office in New York or Chicago, or write directly to Lima-Hamilton, Hamilton, Ohio.

LIMA HAMILTON CORPORATION

DIVISIONS: Hamilton, Ohio—Hooven, Owens, Rentschler Company; Niles Tool Works Company. Lima, Ohio—Lima Locomotive Works Division; Lima Shovel and Crane Division.

PRINCIPAL PRODUCTS: Hamilton diesel and steam engines; Hamilton heavy metal stamping presses; Hamilton-Kruse automatic can-making machinery; Niles heavy machine tools; Special heavy machinery; Heavy iron castings; Weldments; Locomotives; Cranes and shovels.

DIESEL-ELECTRIC LOCOMOTIVE

BY C. F. FOELL
AND M. E. THOMPSON

THE BOOK FOR THE "AGE OF DIESEL" IN RAILROADING

658 PAGES—560 ILLUSTRATIONS

Yes, the trend today is to Diesel in the railroad field. And with this extraordinary volume on the DIESEL-ELECTRIC LOCOMOTIVE, you have the most up-to-date and comprehensive treatment of this field that is obtainable.

Here you'll find the railroad Diesel from A to Z; its history, advantages, engineering, construction, operation, principles of maintenance and selection to meet varying conditions of expected use. It is a basic handbook designed to answer every conceivable problem. At the same time, it is keyed to the practical conditions of operation, and discusses and presents all the specific types of engines.

Railroad officials call this the most genuinely useful book on Diesel railroading they have seen. It is an invaluable guide that enables you to have at your side, at very low cost, the answers to every question that may arise to puzzle you.

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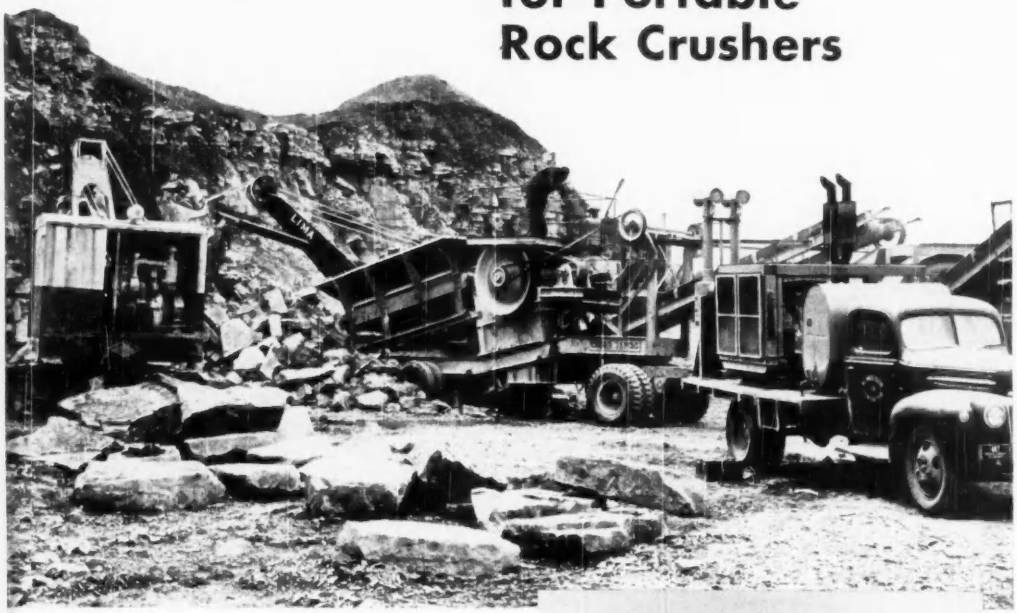
Best Power there is

for Portable Rock Crushers



A truck-mounted GM Diesel Twin Six drives the 40" hammermill, a single six powers the 20" x 36" jaw crusher on this Cedar Rapids portable unit, one of two GM Diesel-powered plants operated by B. L. Anderson in eastern Iowa. Each plant averages 130 tons of ¾" road rock per hour. Operating 18 GM Diesel engines in various pieces of equipment, Anderson has lost only one day's operation in three years due to engine failure.

THAT'S what hundreds of operators like B. L. Anderson of Cedar Rapids, Iowa, are saying about General Motors Series 71 Diesels—and with good reasons.

GM Diesels pack lots of rugged power, yet their sensible size and weight make them easy to move and simple to set up. Efficient factory-built multiple engine units are available. Virtually every power need can be filled.

ALL GM Diesels are 2-cycle, with power at every piston downstroke. They're smooth-operating—easy to start on their own fuel—and quick to respond when picking up a load.

These qualities are important in any rock-crushing operation. So it's certainly worth while to get full information on these hard-working, easy-to-maintain 2-cycle Diesels. Drop us a line and we'll see that you get it.

DETROIT DIESEL ENGINE DIVISION

SINGLE ENGINES... Up to 200 H. P. **DETROIT 28, MICHIGAN** MULTIPLE UNITS... Up to 800 H. P.

GENERAL MOTORS

GM GENERAL MOTORS DIESEL POWER

DIESEL BRAWN WITHOUT THE BULK

(Partial view of the enormous new lubricating oil plant at Lake Charles, La., where this great new oil is processed.)

"ANTI-FOULING" OIL made by the Remarkable new "HEART-CUT" PROCESS

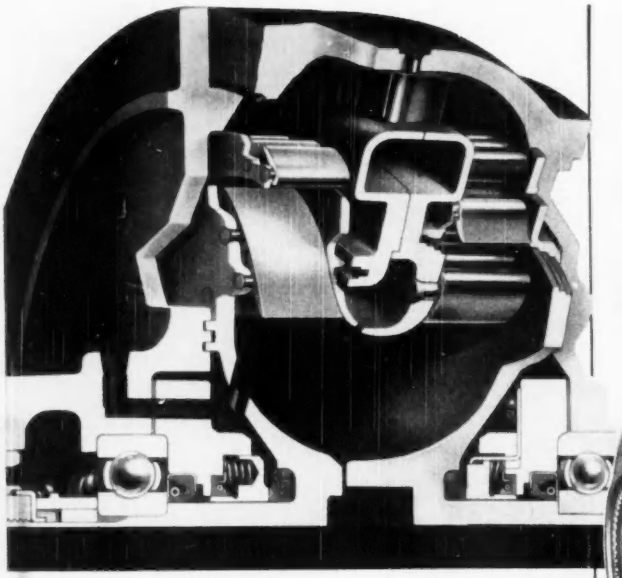
This new oil—the best known to science... gives you a cleaner engine... more economy ...minimum carbon residue.

It's here now! The remarkable motor oil from the giant new $42,000,000 lubricating oil plant at Lake Charles, La. The plant that's been the big talk of the oil industry for months.

New Premium Koolmotor is made by the unique "Heart-Cut" Process which retains only the choicest part of the finest crudes. *It's so superior that in recent engine tests it outscored nine other major premium motor oils.* No wonder Premium Koolmotor is better in every way! Cleans better, seals better, cools better and fights acid, sludge and corrosion far more effectively. Switch to this remarkable new oil today.

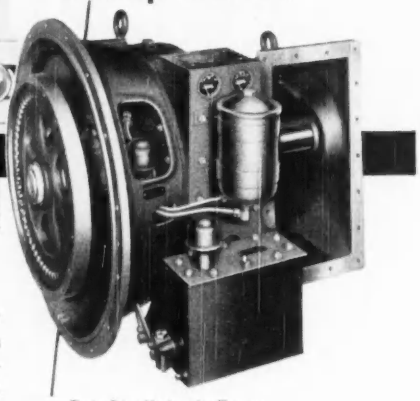
start saving Dollars today... stop at

CITIES SERVICE



Sectioned view of Twin Disc Hydraulic Torque Converter

Greatest Overall TORQUE Multiplication



Twin Disc Hydraulic Torque Converter (Lysholm-Smith Type)

When considering power transmission units for equipment with high torque demands, designers turn naturally to Twin Disc's Lysholm-Smith Hydraulic Torque Converter, because it offers the greatest overall torque multiplication of any unit made today.

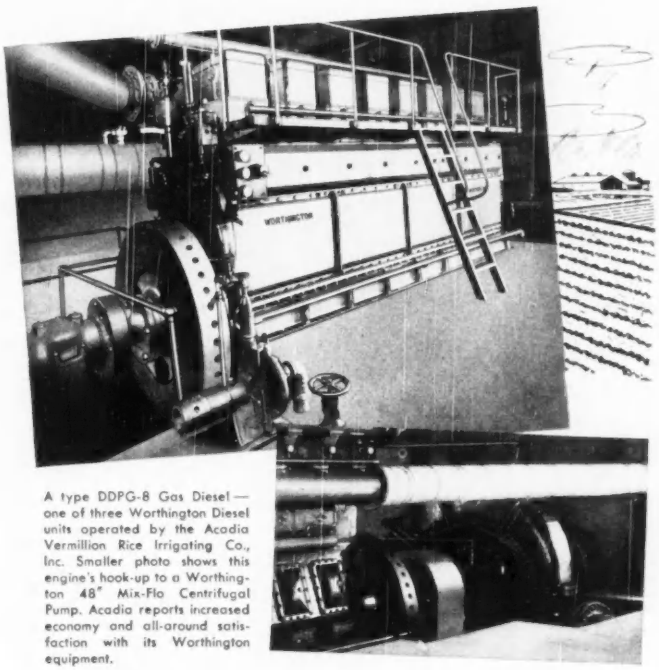
The hydraulic circuit of Twin Disc's Converter consists of a centrifugal pump discharging through a *three-stage* turbine, with two reaction stages interposed between the turbine stages. Maximum torque is developed at output shaft stall and is approximately five times engine torque . . . maximum efficiency is attained at an output speed ratio of approximately .5.

To apply a Twin Disc Torque Converter to any engine and machine assembly, it is necessary to select a converter with a proper pump size to absorb engine hp over its complete operating range. The drive ratios in the machine must be properly selected to obtain maximum converter performance throughout the complete range of output shaft operating speed.

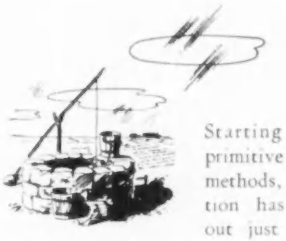
The Twin Disc Hydraulic Division offers assistance in solving your power transmission problems. Torque Converter models are currently available with horsepower ratings from 40 to 1000 hp. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).

SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

LOOKING FOR EFFICIENT, COST-CUTTING POWER?... ASK THE INDUSTRY THAT'S "*Tried Everything*"!



A type DDPG-8 Gas Diesel — one of three Worthington Diesel units operated by the Acadia Vermillion Rice Irrigating Co., Inc. Smaller photo shows this engine's hook-up to a Worthington 48" Mix-Flo Centrifugal Pump. Acadia reports increased economy and all-around satisfaction with its Worthington equipment.



Starting with primitive hand-methods, irrigation has tried out just about every type of power ever developed. That's why the experience of this industry — as old as agriculture itself — should prove of especial interest to *you* in your own search for efficient, economical power.

At Milton, La., for example, the Acadia Vermillion Rice Irrigating Co., Inc., operates a pumping station with a capacity of 350,000 gpm. Supplementing older steam-driven equipment, the company has added three Worthington Diesels: two Type DD-8 Oil Diesels, installed in 1939 and 1942, and a Type DDPG-8 Gas Diesel, installed in 1948.

Running Costs Reduced

Acadia states their Worthington units are entirely satisfactory. In particular, the Gas Diesel is outstanding for its amazingly economical use of fuel. Chief Engineer J. W. Embry submits the following figures, checked over a 24-hour period:

WORTHINGTON DDPG-8—Pumped 96,408,000 gallons. Gas fuel cost cut to less than half.

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EA-7

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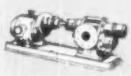
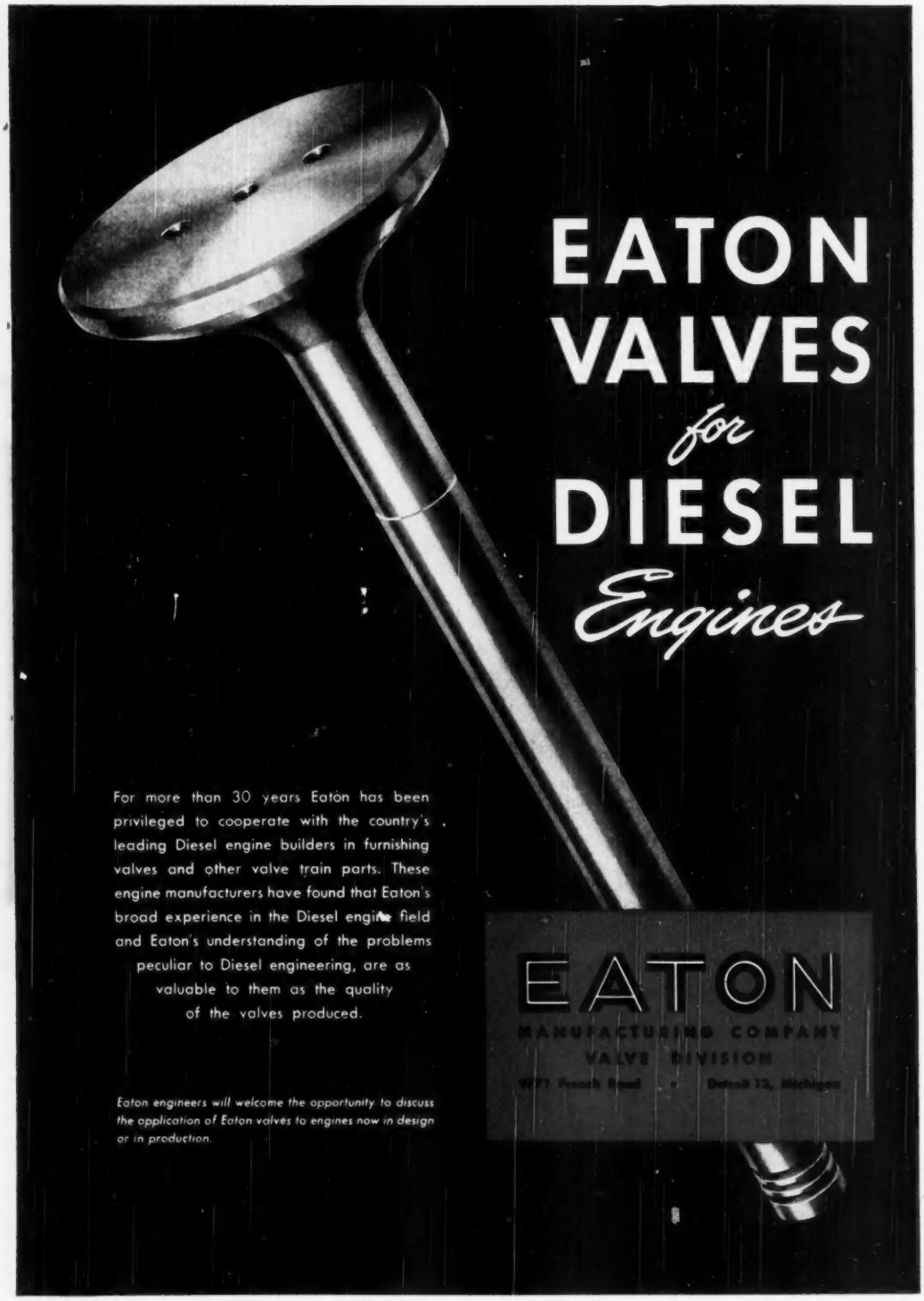


Oil Transfer Pumps

Cooling Water Circulating Pumps

Evaporative Type Engine Water Cooler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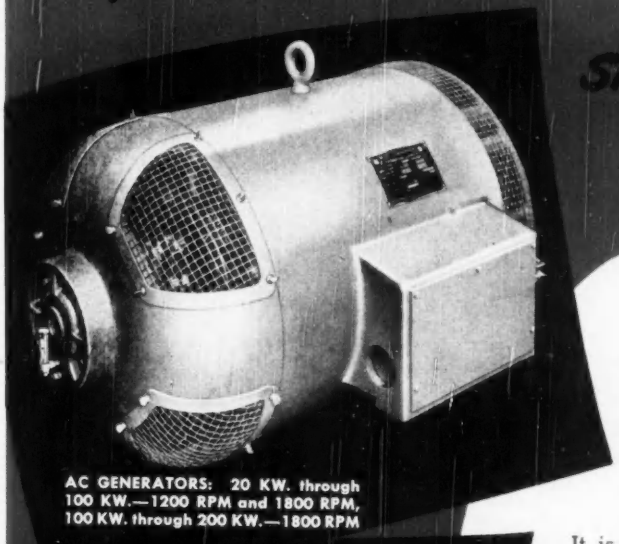
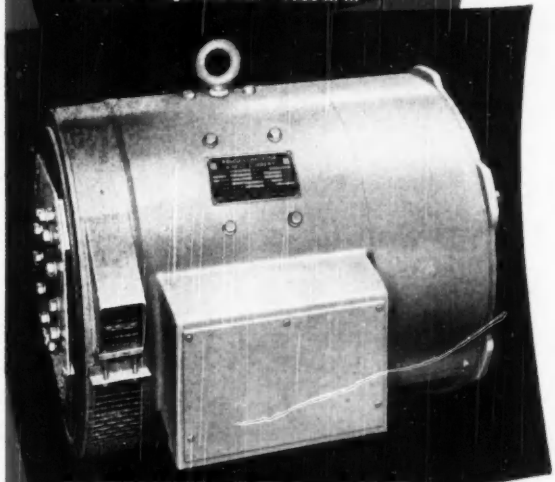
skinflints on COSTS



AC GENERATORS: 20 KW. through 100 KW.—1200 RPM and 1800 RPM, 100 KW. through 200 KW.—1800 RPM



DC GENERATORS: 20 KW. through 60 KW.—1200 RPM, 75 KW.—1500 RPM

To provide a dependable source of electric power is the primary purpose of a generator, it is true. And to find a generator that will supply electric power at a *low cost per year* is the goal of all manufacturers of Diesel power-and-light equipment.

It is in this low-cost-per-year aspect that Delco generators are favored. They have features of design which yield advantages in size, weight and ease of service; they have features of construction and items of equipment which are often classed as *extras* but which remain *standard* with Delco.

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DELCO GENERATORS

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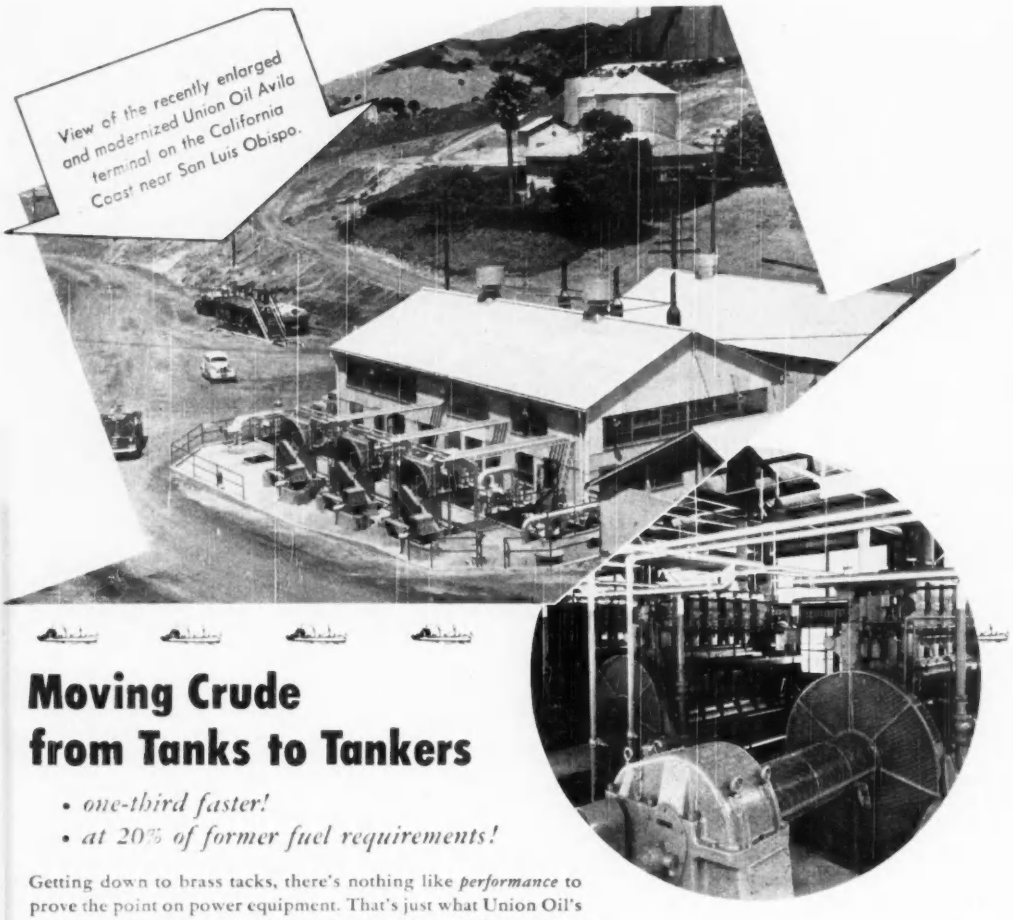
Division of General Motors Corporation, Dayton, Ohio

SALES OFFICES: CINCINNATI • CHICAGO • CLEVELAND • DETROIT • HARTFORD



View of the recently enlarged and modernized Union Oil Avila terminal on the California Coast near San Luis Obispo.

Moving Crude from Tanks to Tankers

- *one-third faster!*
- *at 20% of former fuel requirements!*

Getting down to brass tacks, there's nothing like *performance* to prove the point on power equipment. That's just what Union Oil's three new Enterprise Diesels are doing at their Avila pumping station. Figures show a reduction of tanker loading time by one-third—coupled with an overall saving of 80% to 90% over former fuel requirements. Rated 20,000 B/H capacity, here's a typical loading operation at Avila that's hard to beat for cost-saving, time-saving efficiency:

S.S. Lompoc—June 15-16, 1949

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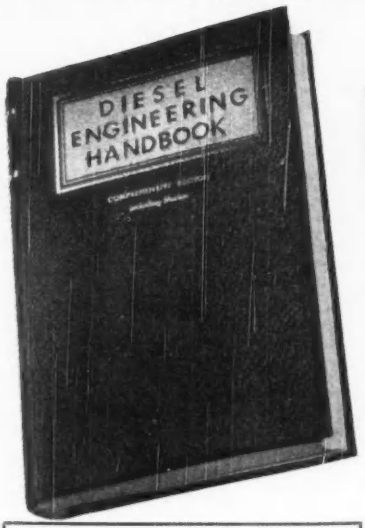

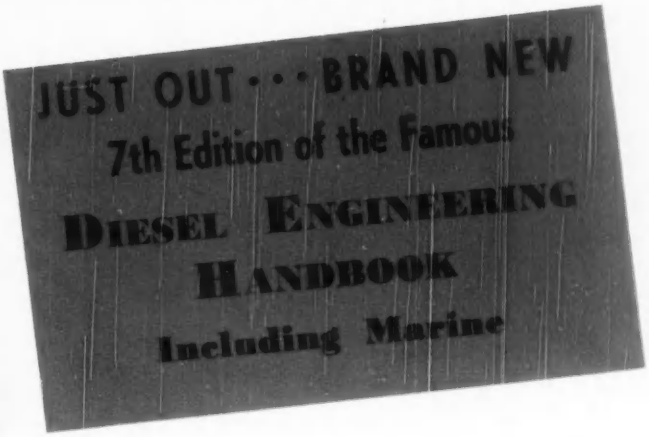

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1. Any sore that does not heal
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Vol. 28 No. 3 March, 1950

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Exhaust sides of the Superior engines at Freeburg. Turbochargers are by Elliott-Buchi. Conversion from steam to diesel power has saved the municipality $20,000 per year in fuel alone. For further details see pages 56 to 58.

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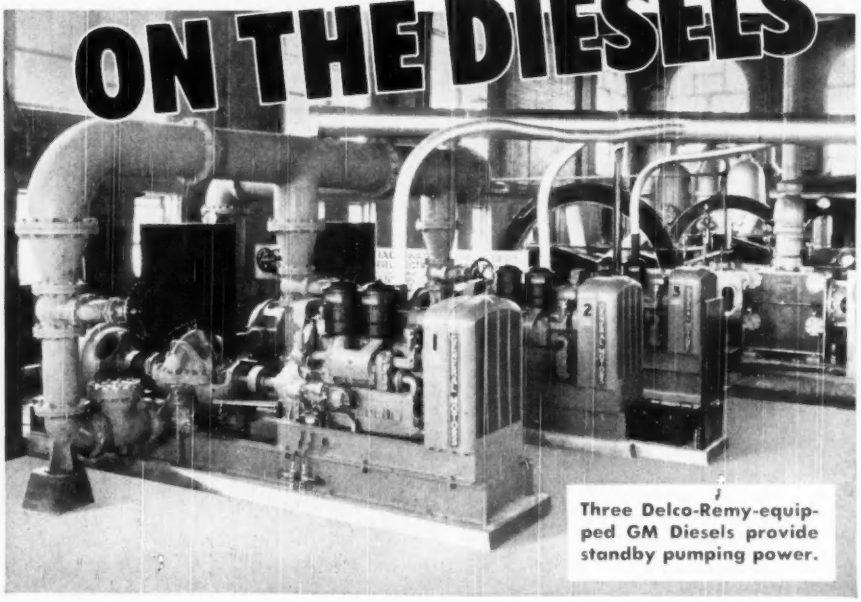
DELCO-REMY

ON THE DIESELS



Three Delco-Remy-equipped GM Diesels provide standby pumping power.

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Editorial:

Fuel Specifications — Are They Too High?

THERE is only one justification for the use of diesel engines and that is that they produce power for less cost than other available prime movers. The high degree of fuel utilization and the low cost of the fuel have been the major factors in providing the advantage held by diesels.

Utilization of fuel is inherent in the diesel principle and is constantly being improved by design progress. Cost of fuel is a factor not within the control of the diesel industry and is, in fact, influenced by the economics of the petroleum industry. Many factors and many industries, in turn, determine the course of the petroleum industry.

The situation, then, with respect to diesel fuels is complex and variable. As an example of the change through the years, at one time there was little demand for the distillates. These were of the straight-run variety and of excellent quality. This was before the days of expansion in the diesel industry, itself, and the use of oil for house heating. From the production angle, it was also before catalytic cracking was common.

Today, diesels are only one of the many competitors for distillates — and it might be added, not the largest by far. They are, however, one of the most selective. Take the matter of cetane rating, for example. High cetane fuels will assist starting particularly in cold weather, promote smoothness of operation due to the reduction in ignition lag, and minimize any tendency toward exhaust smoke. Thus, such fuels are desirable.

Let's take the refiners' viewpoint on the high cetane fuels. The largest single market for petroleum products is the automotive field with its total registration of over 40 million autos, trucks and busses. Their annual mileage is over 400 billion miles and this requires a lot of gasoline. You know what you paid for that last tank of gas. To meet the demand, the refiners are installing more and more catalytic cracking capacity in order to economically obtain the maximum yield of gasoline from the crude.

Now, here is the rub. The straight-run gas oil fractions that are required for charging stock for the "cat" crackers are also the most suitable for high quality diesel fuels. If these fractions are diverted to the diesel market, the yield of the higher cost gasoline is lost. Consequently, one must expect to pay more for the straight-run diesel fuels.

Cracked and thermal stock are perfectly suitable for average diesel requirements and constitute the bulk of the available supply. Continuing the discussion of the single mentioned quality, the cetane number, this will be lower than in the case of a comparable straight-run gas oil. Further refinement to improve the quality is impractical from a cost point of view. Selection and segregation of the better of these cracked stocks for use as diesel fuel would not only add to the cost but would restrict the quantity of fuel available.

Some of the engine builders are fully aware of the situation and are relaxing their specifications in some respects on the basis of experience in the field. Many operators are using lower specification fuel on their own initiative but generally on the basis of competent engineering advice. Peculiarly enough, some operators are taking the super-cautious path and are penalizing themselves by rigid adherence to specifications even after the engine builder has relaxed them. Perhaps, lack of knowledge of the subject inspires this conservative course.

We are by no means advocating that fuel specifications be ignored. Arbitrary use of inferior fuels can only lead to trouble. We do feel that more attention should be devoted to a determination of exactly how far one can go in reducing the specifications suitable for the various services for which the engines are used. The next step is to make this information available to all concerned for their guidance.

An operator might be disposed to take a calculated risk in the interest of over-all economy by using a cheaper fuel — providing that he was competently advised of the probable sacrifice in performance and the extent of increased maintenance. In other words, fuel specifications should be related to the required standard of performance. They should also be promulgated with the refiners' situation in mind to insure that they fall within the range of fuels that are readily available at reasonable cost.

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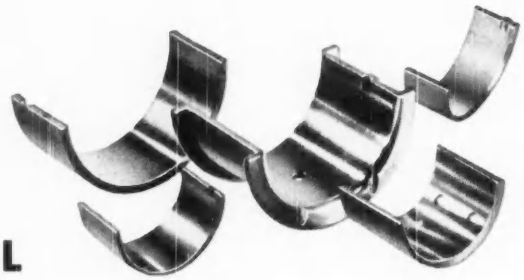

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FEDERAL Mogul Silent SLEEVE BEARINGS

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+ HIGHLIGHTS +

● The past year has been the most successful peacetime year for the diesel engine governor department of the Woodward Governor Company.

● The diesel equipment division of GM has produced more than 12,000,000 hydraulic valve lifters for three GM car lines.

● Continuous quench oil purification saves Cleveland Graphite Bronze, makers of diesel bushings and bearings, $6355 annually. The firm uses Honan-Crane equipment to do the job.

● Seventy-nine railroads use Vapor train heating controls in passenger cars and Vapor Steam Generators in diesel locomotives to supply steam for diesel trains.

● To counteract much of the bad publicity recently received by large truck lines, 53 executives of large truck lines, most of whom operate diesel trucks, have planned an expanded public relations program.

● In an effort to boost exports to the dollar area, Sweden is granting preferences in issuing building permits, allocating materials and import licenses to companies producing for export to the dollar area.

● A total of 787 industrial workers who saved their sight by remembering to wear safety glasses have qualified for membership in the Wise Owl Club, organized by the National Society for the Prevention of Blindness 16 months ago.

● Sewage contributed from a population of 500 persons will yield sludge enough to produce one horsepower per day when the sludge is digested and the gas utilized—another good reason for the use of dual-fuel diesels in sewage disposal plants.

● The number of diesel locomotives in use on the Canadian Pacific Railway has increased from 5 in 1943 to 132 in 1949.

● The Sperry Reflectoscope has been applied to inspecting diesel crankshafts, its latest job being the inspection of a 26-year-old diesel crankshaft.

● In 1949, class I railroads installed more new locomotives than in any year in 25 years, there having been 1393 diesel and 57 steam locomotives.

● More than $5,000,000 in awards have been paid out to General Motors employes in the U. S. since the GM suggestion program was inaugurated in April, 1942.

● There were approximately 7,307,000 trucks and buses, many of them diesel-powered, registered in the country for 1949. This represents an increase in registration of 6.1 per cent over 1948.

● An estimated saving of better than $3.25 an hour has resulted from use of a 44-ton GE diesel-electric locomotive operating over the "billy-goat" profile of the Amador Central Railroad in California.

● A new liberalized social insurance program covering all employes has been inaugurated by the Dravo Corporation. The program provides for life insurance, accident and sickness benefits, hospitalization insurance and surgical benefits.

● Mack Truck Corp. continued to enlarge its program to promote the diesel industry by opening two free schools for diesel mechanics last month, one in New York and one in Boston. The firm is doing an excellent job for the industry as a whole in this enlightened public-relations and advertising project.

● Receipts from federal taxes on lubricating oil during 1949 were approximately $83,000,000, a slight increase over the net for 1948.

● Internal-combustion engines and diesel locomotives are allowed to be imported into Belgium and Luxembourg free of duty.

● More than 1500 persons are expected to attend the 47th annual meeting of the American Road Builders' Association March 6-9 at Netherland Plaza Hotel in Cincinnati.

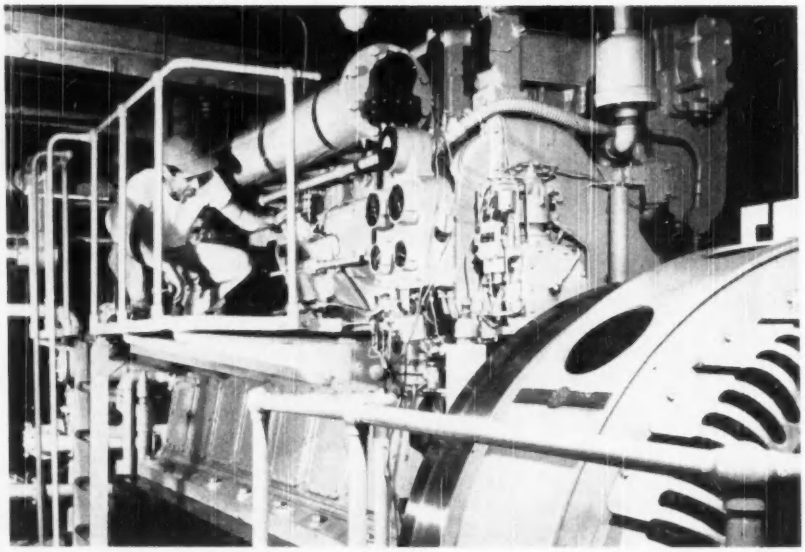
● A production technique gaining more and more utilization in industry is centrifugal casting. Many firms in the diesel industry are using this technique to great advantage.

● The "GM Diesel Quiz", a new pamphlet describing the features, characteristics and application of the GM diesel engine, was recently put into circulation by the Detroit Diesel Engine Division.

● An estimated 7250 wildcat wells were drilled by the petroleum industry in 1949, the greatest number in any one year since the discovery of oil in 1859, according to the American Petroleum Institute.

● General Electric will soon send its "More Power to America Special" train containing more than 2000 electrical products, processes and techniques on a nationwide tour. The nine-car exhibit will be hauled by an Alco-GE diesel-electric locomotive.

● The discovery of a mountain (literally) of almost pure iron ore in Venezuela by U. S. Steel has caused great interest, not only in steel circles, but in all other industries using steel since the find is as big as the Hull-Rust-Mahoning mine near Lake Superior.



Nantucket's diesel operating on heavy fuel. Lagged riser to left of generator nameplate contains final preheating element.

Nantucket Reports on

Heavy Fuel Operation

A little over a year ago, The Nantucket Gas and Electric Company installed their first diesel engine, a Cooper-Bessemer Type JS-8T. Their purpose was to increase their generating capacity, provide a reserve of power in the event of trouble with any of their generating units and to hold their rate structure in the face of rising costs as well as, perhaps, make a little money. Economy of operation is frequently a comparative thing and Nantucket falls in this category.

When the installation was first reported (*Diesel Power, October, 1948*) the factors peculiar to Island and resort operation as well as those of a purely local nature were outlined. Just as a refresher these will be summarized. Insular operation is always expensive because of the large increment for transportation that must be added to all costs. Add to this the fact that Nantucket is a popular resort with an attendant influx of population for the summer season. The result is a plant running capacity factor of 32.2 per cent. In the winter time, the return from the reduced number of meters on some of the longer transmission lines hardly covers the transformer losses.

From this it can be seen that the problem is not one of showing exceptionally low rates but, rather, one of keeping them from being prohibitive. This has been done by recourse to every possible economy.

Since bulk transportation of supplies is generally cheaper, storage facilities for the gas enrichment oil required in the production of household gas and for use in the steam boilers was predicated on the capacity of one of the small tankers of the supplier, the Sun Oil Company. Rather than split loads (increasing cost) or install additional tankage, it was decided to use this residual fuel in the engine after the feasability of the procedure was agreed upon by the engineers of the Public Utility, the engine builder and the oil supplier. This report will cover some 6400 hr. of operation using this fuel.

Other problems had to be considered in the original installation. Two steam turbines previously supplied power but they were getting old and lacked the reserve capacity needed. The engine was to be installed in the existing building which precluded any possibility of sinking piles or otherwise improving ground stability. A high water table acted as a hydrostatic system to transmit vibration for long distances. Then, the plant is located right in the town of Nantucket with the result that noise and smoke is intolerable. Add to all this the fact that cyclic control had to be maintained within 3/5 of a cycle as the power was used for an aircraft radio beam.

Flotation for the engine was assured by the construction of a reinforced concrete "boat". A heavy block of similar construction with lateral steel support members was mounted in the boat with the ends of the five supports resting on Korfund spring vibro-isolators with four snubbers

placed under the end beams. The high inertia of the mass plus the dampening devices effectively stopped the transmittal of engine impulses to the surrounding structure and the ground.

Maxim spark arrestors and silencers reduced exhaust noise to acceptable levels. Smoke as the result of incomplete combustion was eliminated in the normal load range by a system of preheating the heavy fuel prior to introduction into the injection system.

Such were the details of the installation when it went into operation near the end of August, 1943. In the operation it was intended to utilize the diesel for base loads with the steam units for peaks and stand-by use. The promise of burning comparatively low cost, heavy fuel eliminated the fuel cost differential factor between steam and diesel power, permitting full use to be made of the greater thermal efficiency of the diesel.

The nozzle tips used were standard for the engine on normal fuel and these have been retained in service. Difficulty in reaching full power output of 700 kw. was encountered and probably could have been overcome by the use of larger orifices or, perhaps, higher injection pressures. However, in view of the low load factor on the engine, 198 per cent of the load was less than 700 kw.) it was decided to retain these nozzle tips and revert to the use of the lighter fuel at such times as full power was required. It was felt that since these periods were few and far between, better fuel economy under normal loads could be obtained and that the added cost increment due to the occasional use of the light fuel was negligible.

The petroleum product used for gas enrichment, boiler fuel and, now, in the diesel was a selected residual fuel having the following general characteristics:

Gravity-A.P.I. 160 F.	(Approx.) 16.0-19.9
Flash-Pensky-Martens Closed Cup	150 F.Min.
Viscosity-Saybolt Furol 122 F.	150 Max.
Conradson Carbon %	9.0 Max.
Ash Content %	0.1 Max.
Water & Sediment %	0.5 Max.
As-Sulfur Content %-ASTM	1.00 Max.
Billing Weight-Lbs. Gal.	7.935
Btu. Value Gal. (Approx.)	150,700

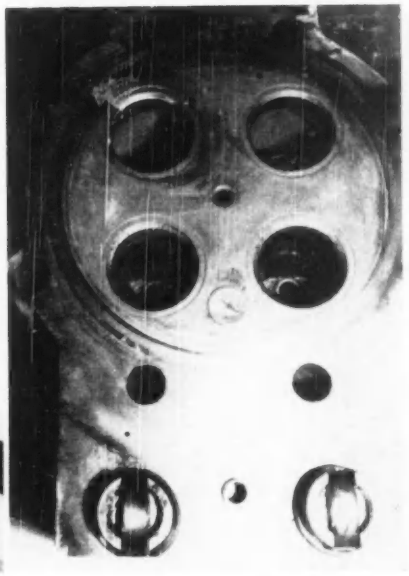
Special handling was required and involved preheating, centrifuging and filtration. Light diesel fuel is used for starting, for a period before stopping, and at such times as the maximum or overload conditions are expected.

The only modification of the system for light fuel was the addition of a 50-gal. gravity tank. This was mounted on the roof to provide a head for dead starting when other elements of the plant were shut down.

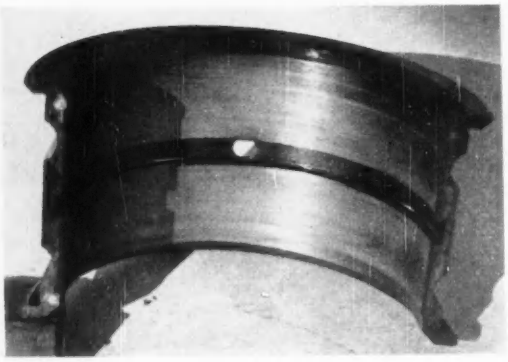
A minor modification was also made in the heavy fuel oil system. Oil was and is bled from the boiler fuel system and pumped to the suction of a Sharples centrifuge unit. The oil flow and pressure to the centrifuge and the filters is controlled by means of a throttling valve. Heating coils in the tank can control the temperatures from 130-deg. F. required for effective centrifuging, up to 205 deg. The oil is under pressure as controlled by the transfer pump relief valve and then undergoes a final preheating. A General Electric *Calrod* heating element inserted in an expanded section of piping near the high pressure fuel pump performs the heating function.

This unit is automatically controlled by a temperature sensitive element in the outgoing line to the engine. It was found that the oil temperature fluctuated widely with varying loads and that under some conditions the unit would cycle rapidly. This situation was corrected by the use of an element

A piston as removed. Rings are free despite some carbon and gum. Lacquer stain uniformly covers skirt.



Far right — Cylinder head showing condition of the seats. Exhaust seats at top show slightly better condition.



A bearing shell typical of conditions found. Light scratching is noticeable but overall condition is excellent.

with three ratings, 500, 1000 and 2000 watts, with external manual control of the wattage rating. This permits selection of the appropriate heat capacity to suit the rate of fuel flow (as a funcion of load) to the engine. Temperatures can now be held within 6 or 7 deg. of the required temperature. The pressurized fuel is heated to 220 deg. F.

The engine has been in operation for a period sufficient to permit some conclusions to be drawn. A partial report on the total number of hours during which the engine has operated is tabulated below. The format used is generally the same as that for the ASME Annual Report on Oil Engine Power Cost.

By all comparisons, it can be seen that the operating data is well in line with results obtained with more conventional diesel fuels. The operating record is extremely good when the running capacity factor is taken into account.

In order to complete the operational picture, engine condition must also be taken into account. There have been a number of cases in the past where any saving due to the use of a heavier, cheaper fuel were offset by increased maintenance costs. Such operation is impractical.

In this case, it is possible to make the flat statement that wear was not only normal but according to well accepted standards, better than normal. The engine was taken down for inspection after more than 6400 hr. of operation and all of the parts critically examined and measured.

Before discussing the various parts, it would be well to consider the effects of the extremely high Conradson Carbon fuel oil on general engine condition. As might be expected, the lubricating oil quickly became dirty as the result of fuel soot. The nature of contamination was colloidal rather than one of suspension. Sun Oil Company lubricants were used and while these did a fine job of keeping the engine clean, the large amounts of contaminants were more than could be coped with and some soft carbon deposits formed.

Data compares favorably with plant operation on conventional fuels

A great deal of this fuel soot was removed by the absorbent type filters necessitating a rigid schedule of filter element replacement. Periodic checks were made by Sun Oil Company to determine the suitability of the lubricating oil for further use. It was found that in spite of the color, the oil was satisfactory. This might be cited as another example of how lubricating oils are called upon to correct conditions induced by other factors.

In an effort to remove more of the contaminants and thereby lessen the filter load and the carbon forming tendencies, the management is now installing a DeLaval Puri-Filter unit consisting of a centrifuge, heater and three Fram *Filcron* filters.

It is interesting to note that many of the usual tests applied to lubricating oils have no significance here. For example, the degree of fuel dilution is very difficult to assess because the viscosity of the diluent is greater than that of the lube oil. In addition there are relatively no light ends to lower the flash point. Thus, the methods of field testing that are becoming more popular and are based on reduction of viscosity or flash point as a measure of dilution do not apply.

The fuel apparently has excellent lubricating qualities and less tendency to destroy existing lube oil films, as evidenced by the low rate of wear. However, the high carbon content and perhaps the sulfur content tend to produce sludge, gum and carbon. This is evidenced by the condition of the parts.

Cylinder Heads and Valve Gear

As a result of the condition of the lube oil, the areas around the rocker arm assembly were very dirty with a generous amount of gum and soft carbon. Oil passages, for example to the valve stems, were open but somewhat restricted. These could easily be cleaned. The portion of the head facing the combustion chamber had a normal deposit of carbon.

All of the valves were free in their guides. There was some indication of guide wear but this was found to be only 0.002 in. in most cases, with a maximum of 0.003 in. as determined by the pilots used when grinding the valve seats.

The valve seats were found to be in very good condition with only minor pitting. The exhaust valves were pitted and had apparently developed a ridge from pounding. Pits were of

a peculiar nature resembling slight tears around the face. Carbon deposits were normal with little showing on the stems. The intake valves were also pitted and showed a heavy deposit of soft carbon on the head and up the stem. The valves were all refaced in a shop off the island and upon their return it was necessary to touch up the seats to match the face angle.

An interesting condition was noted in the intake manifold. It became progressively dirtier, cylinder by cylinder. The outlet from the turbocharger compressor was clean and at the opposite end of the manifold by No. 8 cylinder, there was a pool of oil. The turbocharger showed no record of excessive oil consumption and the only conclusion that could be made was that the oil accumulation was the result of leakage past the intake valve stems. By contrast, the exhaust manifold and turbine blading, which might be expected to have considerable soot accumulation in view of the type of fuel being used, were very clean.

Piston and Rings

The condition of the lube oil was also reflected in the condition of the pistons and rings. Carbon on the piston head was normal but carbon and gum were found on the balance of the surface. The skirts had a thin lacquer coating no doubt due to the sulfur content of the fuel.

Four of the top rings were found to be stuck while the balance of the compression rings, in spite of the carbon formation, were free with bright faces. Ventilation grooves in the oil rings were pretty well plugged with soft carbon. However, it was reported that conditions were similar when an inspection was made after about 2000 hours of operation and the oil consumption showed no signs of increase in the ensuing period.

All of the rings showed signs of loss of tension which, again, is to be expected. A full new set of rings was installed.

Cylinder Liners

Principal interest concerning the effects of burning this heavy fuel is centered in the condition of the liners. These were in excellent condition.

Liner Wear Measurement

	Top of ring travel at counter bore		2" Down from Counter Bore		16" Down from Counter Bore	
	Across Crank	Along Crank	Across Crank	Along Crank	Across Crank	Along Crank
Cyl #1	13.003	13.002	13.001	13.002	13.0005	13.0005
" #2	13.0025	13.0015	13.002	13.003	13.000	13.001
" #3	13.001	13.0015	13.000	13.0045	13.0005	12.999
" #4	13.003	13.0005	13.0015	13.001	12.999	13.001
" #5	13.003	13.002	13.002	13.001	13.000	13.0015
" #6	13.000	13.002	12.994	13.004	13.0005	13.000
" #7	13.0035	13.003	13.001	13.001	13.0005	13.0005
" #8	13.005	13.002	13.000	13.002	12.999	13.0005

Wear can be seen to be practically non-existant after 6400 hours of operation

Measurements were taken both axially and laterally (referred to the engine) in the bores at the upper limit of ring travel, 2 in. below the counterbore, and 16 in. down from the counterbore. The results are shown in the accompanying tabulation.

Typical wear contours for liners have been pretty well established and indicate that maximum wear occurs at the upper end of the piston ring travel. In this case, the wear was so slight that at other than near the expected point of maximum wear, it was negligible. In fact, it might be assumed that the minute variations were the result of manufacturing tolerances.

The average measurable wear taken laterally at the top of ring travel was 0.0026 in. while longitudinally it was 0.0017 in. Thus, the maximum rate of wear of about 0.00043 in. per 1000 hrs. of operation is convincing proof of the practicality of burning this heavy fuel in these engines.

Bearings

Upon removal of the main bearings for inspection, it was indicated that slightly excessive clearance had been allowed when originally installed. The thickness of the shells was "miked" to determine the amount of wear and they were found to be within 0.001 in. of the original dimension. They were reinstalled with shims removed to provide proper clearance. Leads taken, indicated an average clearance of about 0.003 in.

Connecting rod bearings showed the same amount of wear as the main bearings. The condition of the bearing surfaces was also found to be the same. Scratches and a few imbedded particles were proof that grit or dirt had been present. A damaged lube oil strainer element was found and might account, in part, for this condition. All that was required to continue these bearings in service, however, was a very light scraping to remove the particles and clean up a few minute extrusions caused by the scratches.

General

While the engine was apart for general overhaul and inspection, routine checks were made on all components of the engine. Outside of the general dirty condition of all parts of the engine coming in contact with the lube oil, only a few adjustments were required.

One of these concerned the fuel injector settings. Adjustment of the valve lift, amounting to 0.003 or 0.004 in., was needed to correct the timing and compensate for a normal amount of wear of the cam and rocker noses. In addition, some of the valves required lapping due to slight leakage.

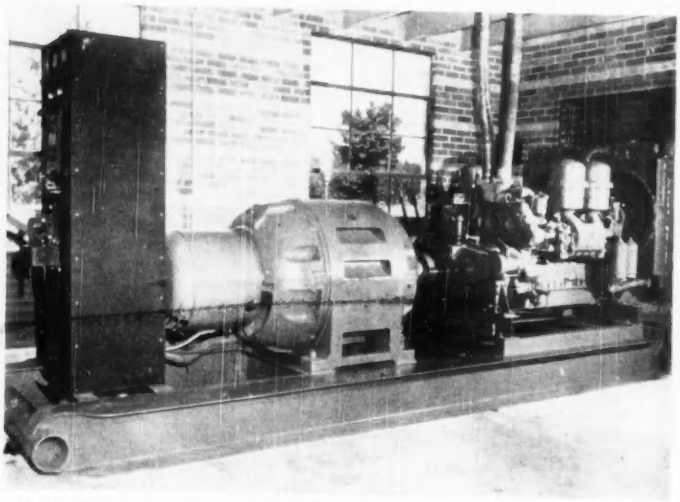
Some difficulty had been encountered with sluggish regulation of injection pressures that can probably be attributed to the characteristics of the fuel used. This was eliminated by installation of the new type JS fuel pump.

In the words of the Cooper-Bessemer service engineer Jack Atkinson, "All in all, the engine was in good condition, better, I think, than was expected by all concerned. She should do still better with the new lubricating oil filter set-up."

Mr. Mather, Vice-President and General Manager, representing the Nantucket Gas and Electric Company, put the final stamp of approval on the project when he commented, "From our point of view, the installation is a success."

Standby Diesel Power for Beaumont

*by John D. Southwell**



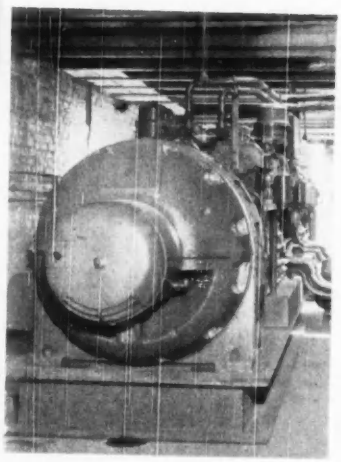
The diesel installation which can provide emergency pumping power for the city of Beaumont.

WHEN the city of Beaumont, Texas, needed standby units to furnish emergency power for water pumping stations, water department engineers selected General Motors Detroit diesel-power, as the combination most applicable to all of their requirements.

Beaumont takes its water from two different stations on the Neches River. Under normal conditions the water is obtained from 20-mile distant Burns Bluff in a gravity flow. But three to six months out of the year this supply is contaminated with salt from the nearby Gulf of Mexico. Salt contamination results from a combination of seasonal storm tides and low flow of water in the Neches River. During this three to six month period, water must be pumped from a station at Weiss Bluff, some 30 miles away.

Because of its relatively low cost in the Beaumont area, electric power is normally used to run the water works. However, because electric power is subject to disruption by storms, standby power was required in order to assure continuous water services and to give the citizens the benefit of low insurance rates.

End view of installation showing General Electric generator in foreground. Note the electric driven radiator at right.



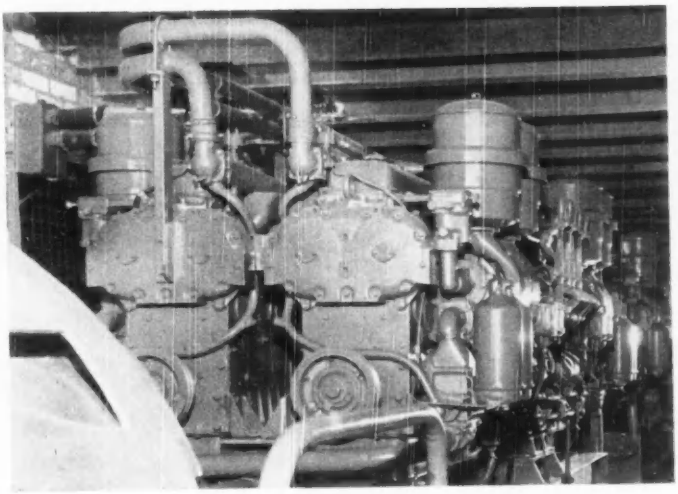
Steam generating units had been used in the past as standby power, but they were expensive to operate since a full head of steam had to be kept up at all times. Steam powered units were a handicap, too, in that our limited housing facilities were not sufficient to allow for the amount of steam equipment necessary to take over all phases of operation. The proposed expansion program for the Beaumont Water Works and the proved inadequacy of the steam units indicated that a change of power was necessary.

Under the direction of Hugh Blevins, Superintendent of Beaumont Water Works and F. H. Newan, Superintendent of production, we studied the situation thoroughly and investigated all types of power. Natural gas, which is the cheapest and most plentiful fuel in the Beaumont area, was not the answer because gas lines are subject to disruption by storms, tides or bombing in the event of war. We needed completely self-contained standby units, the fuel for which could be kept on the premises, so that it would be readily available in an emergency. We needed units that could supply emergency power for all phases of water plant operation including pressuring, filtering and pumping, as well as provide power for emergency operation of police and fire department radio.

The amount of space available for our standby installation was limited. Because of the prohibitive expense of constructing new and larger buildings, we preferred to use for the main plant the same space which formerly housed the old filter plant equipment. This was in one end of the filtration building which had no special foundation and only 8 ft. 8 in. of headroom. Our diesel generating units had to be sufficiently compact so that they could be maintained successfully in very close

*Electrical and Mechanical Superintendent for the City of Beaumont, Beaumont, Texas.

quarters. Moreover, we needed a unit that could furnish maximum power with minimum bulk and one that operated with as little vibration as possible. This last factor was important since we had no special foundation on which to bolt the engines; thus requiring a smooth running unit.



Side view showing diesel quads placed end to end.

The engines had to be able to start instantly and take over the full load without delay. Since the engine itself would be located some 300 feet away from the main plant building, a remote control set-up whereby the engine could be started and controlled by a single switch in the main building was necessary. This was necessary because in emergencies the one man on duty would be unable to leave his post at the main control panel.

After considering all available sources in accordance with the specifications drawn up by ourselves and the concern of Freese & Nichols, Consulting Engineers, Fort Worth, Texas, we decided upon diesel power plants engineered and installed by Stewart & Stevenson Services, Houston, Texas. Stewart & Stevenson offered us completely self-contained 400 kw. remote starting units, that could be installed without the expense of constructing a new building or providing any special foundation. The main installation consisting of two Series 71 Quad powered 400 kw. units, was convenient and even more attractive since a GM twin engine driven 200 kw. plant at the Weiss Bluff Station could utilize the same spare parts. The interchangeability of parts made possible through the use of Stewart & Stevenson G. M. Diesel powered generating sets was highly important in our decision on the proper diesel sets, since it eliminated the need for carrying a large parts inventory, and cut down on the cost of maintenance repairs.

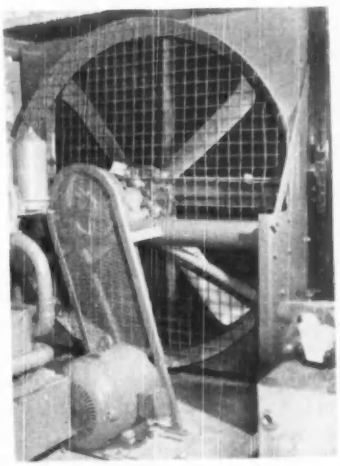
The main plant installation consists of two completely self-contained Stewart & Stevenson 400 kw. generator sets. The generators are General Electric directly connected to General Motors Diesel Series 71 Quad engines through Falk flexible couplings. Generator control panels are Westinghouse.

The two units have a combined capacity of 800 kw. at 60 per cent factor. They are capable of operating continually under full load capacities throughout full 24 hour periods without other attention than proper lubrication and cooling. Each completely self-contained generator set is mounted on a rigid sub-base, designed and built by Stewart & Stevenson Services which maintains engine alignment without the necessity of heavy concrete foundations. The radiator equipment consists of two self-contained skid-mounted radiator assemblies with electric motor driven blower-type fans so that the complete radiator can be skidded into the desired position. No other ventilating fans are necessary as the radiator fans take care of both cooling the radiator and forcing the hot air out of the building. Over-all height of the generator sets permit removing pistons and cylinders with a maximum ceiling height of 8 feet 8 inches in the engine room. A special starting panel designed and built by Stewart & Stevenson permits starting of both 400 kw. units within sixty seconds by remote control, attaining full load capacity and automatically paralleling the two units within that time.

There were many engineering problems connected with this installation, including the design of the automatic remote control system, necessitating close co-operation between Freese & Nichols, our consulting engineers, and Stewart & Stevenson Services. The contractors installed, and assumed complete responsibility for the satisfactory operation of the units.

These standby-installations are only a part of a large improvement program inaugurated by the City of Beaumont in 1947. The entire program is intended not only to assure citizens of an adequate water supply in emergencies, but it is also designed to double their present volume of water.

Electric engine-driven radiator on one of the GM diesel quad units. These radiators also exhaust hot air out of the building.



Diesel Motor Trains—I

A recent report concerning the application of diesel motor trains has been published by Northwestern University. Notice of the publication of this report has been given in the columns of Diesel Power & Diesel Transportation (Jan. '50) but it is felt that the report is of such significance that a more complete presentation of its contents is warranted. In this article, a digest of the report is given which should be of great interest to railroads, especially those which are operating suburban feeder lines. The report was written by Stanley Berge and Donald L. Loftus of the Department of Transportation, School of Commerce, Northwestern University.

THE term "diesel motor trains" designates a train which consists of two or more cars, some or all of which are equipped with diesel power plants. The power cars, in contrast to the non-powered cars called trailers, are under remote control from the driver's cab at either end of the train. Like modern diesel locomotives, the power cars are connected by a low voltage control cable running through the entire train. Unlike diesel locomotives, the power cars of a motor train usually contain smaller power plants and in addition have room for seats or other revenue space.

In this country, the diesel motor train is probably best exemplified by the Burlington's "Pioneer Zephyr", the Gulf, Mobile and Ohio's "Rebel" and similar lightweight motor trains of several other railroads. One of the best examples of the multiple-unit diesel-electric motor train is the triple-car articulated design of the Netherlands Railways.

The principal advantages of trains operated without locomotives is their great economy of operation. In addition to economy, the significant feature of small streamlined motor trains has been their attractive high-speed service. The motor train, free of locomotive dead weight, achieves a better rate of acceleration and a higher balanced speed than a locomotive-propelled train of equivalent capacity. Because it has a much larger proportion of total train weight on drivers, and because of its basically higher horsepower per ton of train weight, the motor train can accelerate more rapidly and attain a higher maximum speed than an equivalent train with steam or diesel locomotive. Therefore, it appears to be well suited for suburban and high-speed, main line passenger services with frequent stops.

Motor Train Development

While the earliest rail motor car appears to have been a steam-propelled car built in England, rail motor cars also made their appearance very early on railroads of the U. S. The grandfather of motor cars in this country seems to have been a steam-driven car built in the early 1850's at Manchester, N. H., and used for a time on the Concord Railroad.

The idea of a gasoline-driven car came simultaneously with the earliest development of the automobile. European developments in this field were generally more successful than here but limited success was achieved with four motor cars built in this country around 1900. During the period 1900-1906, a number of motor cars were built and placed in operation in this country but with only limited success.

In February 1906, the General Electric Company in conjunction with the American Locomotive Works built the first gasoline-electric motor car without storage batteries. The car seated 40 passengers in an overall length of 65 ft. and weighed 65 tons ready for service. The car averaged a speed of 35 mph. operating on the lines of the Delaware and Hudson between Schenectady, N. Y., and Saratoga.

Between 1906 and 1914, 33 G-E motor cars were placed in service on branch lines by various railroads. After 1914, the number in operation declined steadily and in the early 1920's only a few were still in service. The main troubles were that the cars were too heavy for their engines and hard to control, both of which resulted in frequent breakdowns.

The first rail motor cars to be operated in commercial service were the McKeen cars built by the Union Pacific in 1906. The standard McKeen car seated 75 passengers in an overall length of 55 ft. and weighed approximately 60,000 lbs. It was powered by a 200-hp. gasoline engine equipped with a direct chain drive for high speeds and a gearbox for low speeds.

Although fairly successful in service, the McKeen cars experienced many breakdowns. Transmission and power plant failures were the most frequent causes. The resultant high maintenance costs and poor schedule reliability tended to offset the economies gained by the use of such equipment.

As early as 1906, the usefulness and economies effected through the use of motor cars, was recognized in a report made before the American Railway Master Mechanics Association, which stated in part: "It is recognized that the so-called motor car . . . occupies a distinct field of usefulness. On many branch lines, now existing, where travel is light, and on new extensions into unsettled country where the business will not return a profit on steam service, it would have to be run at a loss until a sufficient business was induced or built up by the travel facilities afforded. These situations are the distinct field of the motor car, which can be operated for less per car-mile than by regular steam train or electric methods until the volume of business will warrant the regular transportation methods."

Since the early developments previously mentioned, there has been a succession of developments in the motor car field. The twenties found the railbus, which was almost identical to highway motor trucks and buses. These found a definite place in the motor car

Four car "Pioneer Zephyr" of the Burlington placed in service in 1934.

scheme but there was also a need for larger and more powerful cars which was filled by H. L. Hamilton's Electro-Motive Company in 1924. This car was the prototype of most of the cars built in the late 1920's and early 1930's.

Motor trains increased in popularity during the late 1920's, but in the following decade, a marked decrease in popularity was noted. They were largely replaced by the high speed articulated motor train of which two examples are the Union Pacific's "City of Salina" and Burlington's "Pioneer Zephyr"

With the exception of a new type of oil-burning engine and hydraulic transmission incorporated in a number of lightweight "motorailers" produced by American Car and Foundry and two motor trains with light high-speed diesel engines built by the Budd Company, there were no significant developments between 1940 and 1948.

Summary

In summary, seven major points have been brought out in regard to early developments in motor trains. They are:

(1) Three-fourths of the rail motor cars and trailers available for railroad service at the close of 1946 were for multiple-unit electric-central power plant operation in metropolitan areas.

(2) Eight-five per cent of the motor cars with self-contained power plant in 1946 used gasoline as fuel. These cars were approximately twenty years old, lacking the necessary speed and comfort to compete with more modern bus and automobile transportation.

(3) There is considerable evidence that most U. S. motor cars have been insufficiently powered to operate at speeds competitive with highway transportation. A ratio of 3 to 4 horsepower per gross ton was often obtained for the motor car alone — but was inadequate for speed and acceleration with a trailer car.

(4) Motor cars have been economical in local and branch line passenger service. They have been only half as expensive to operate as local trains propelled by steam locomotives.

(5) The local service performed by motor trains in 1948 typically averaged less than 30 miles per hour overall speed with stops at intervals of ten miles or less.

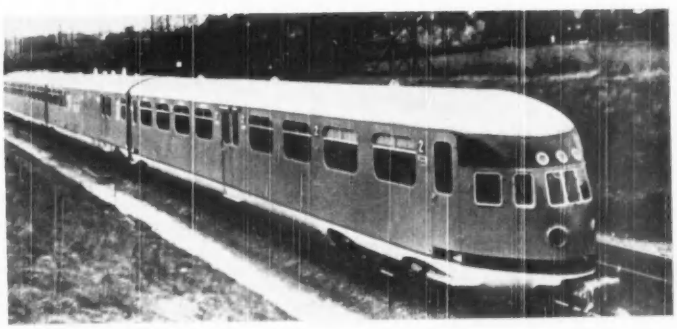
(6) High-speed streamlined motor trains built by Pullman and Budd in 1934, the "City of Salina" and the "Pioneer Zephyr", combined speed and comfort with operating economy. Traffic soon exceeded capacity and interest in lightweight motor trains shifted to heavier trains propelled by diesel locomotives.

(7) A few light self-propelled motor cars built after 1940 by American Car and Foundry incorporated multiple-unit controls, making it possible to operate a series of motor cars from a single control station. The use of multiple-unit controls adds considerably to the flexibility and economy of motor train operation for suburban passenger service.

Experience in Other Parts of the World

The first rail motor car dates back to a small steam-powered vehicle which appeared on the Eastern Counties Railway of England in 1847. The first self-propelled car with gasoline engine was run in Germany in 1887. The first diesel motor car was a lightweight 75-hp. diesel-electric which appeared in Sweden in 1913. More important

Triple-car articulated diesel motor train of the Netherlands Railways.



than these early experiments was the extensive development of this equipment in Europe occurring between 1930 and the beginning of World War II.

As in the United States, many railroads of other countries were confronted with serious declines in passenger traffic during the 1930's. The greatest single cause was increased competition from the highways, particularly in France, Italy and Germany. To meet this situation, many railroads turned to lightweight rail motor cars, or "railcars", and motor trains consisting of two or more cars.

Popularity in France, Italy and Germany

An important factor in the widespread popularity of railcars in Europe was the high average speed maintained by these vehicles. Weight and capacity were often sacrificed to provide speeds competitive with those of highway vehicles. High speed service together with low-cost operation proved the salvation of many lines where falling traffic was causing heavy losses.

At the outbreak of World War II there were reported to be more than 3000 railcars in service on the continent of Europe most of which were diesel-powered. In Germany there were about 300 in operation and about the same number on order. France had 786 cars in service and 50 to 75 on order. Italy was operating approximately 600 railcars and by 1940 this number had increased to 700. In South America, Argentina was the leader with 292 units, and the Queensland Government Railways was the largest user in Australia with 71 cars in service.

First Diesel Streamliner

German engineers made many important contributions toward the development of motor trains in Europe. Notable among these were the diesel engine and the hydraulic transmission. However, probably the greatest achievement on the part of German railway technicians was the famous "Flying Hamburger" of the Reichsbahn (German State Railways). Placed in service in May, 1933, this two-car articulated motor train, or *triebwagen*, was the first high-speed diesel streamliner in the world, preceding by nearly a year the first trains of this type in the United States.

Running between Hamburg and Berlin, a distance of 179 miles, the "Hamburger" maintained an average speed of 75 mph. in regular service. Although designed for a maximum speed of 97 mph., the train often exceeded 100 mph. on its regular runs.

The two-car unit contained seats for 102 passengers, a baggage compartment and a small bar, in addition to the driving cabs at both ends. Overall, the train was 137 ft. 6 in. long and it grossed 85 tons.

Power was provided by two high-speed Maybach V-12 diesel engines, each developing 410 hp. at 1400 rpm. Fully loaded the "Hamburger" had a power-weight ratio of about seven hp. per ton. An engine-generator set was mounted on each outer truck, and the articulation truck carried two traction motors. In addition to a standard braking system, the train was equipped with supplementary electro-magnetic track brakes. Used only in emergencies, this equipment enabled the "Hamburger" to stop in a distance of 765 yards while traveling at a speed of 100 mph.

The streamlined design of the car bodies was the result of a series of wind tunnel tests conducted at the Zeppelin Aircraft Works in Friedrichshafen. Eddies were kept at a minimum in eliminating all sidewall projections and by installing aprons around the bottom. This body design was later copied in motor trains built in Denmark, France, Holland and Belgium.

The success of the "Flying Hamburger" led the German railways to order 13 additional motor trains. These new two-car units were very similar to the original except in one respect: they were built for multiple-unit operation whereas the older unit could only be used alone. In 1935, these motor trains were placed in service on the Cologne-Berlin and Frankfurt-Berlin routes, in addition to the original Hamburg-Berlin run, averaging over-all speeds of 72-77 mph.

Because of the rapidly increasing demand for accommodation on the German "Flyer" services, the Reichsbahn in 1936 turned its attention to motor trains of larger capacity. Similar to the previous two-car units, the first new design centered around a three-car articulated train equipped with two 600-hp. supercharged engines. Of the first four units ordered, two were diesel-electrics and two were built with diesel-hydraulic power. The service weight of the diesel-electric units was 144 tons as against 131 tons for the hydraulic units. Both types seated 139 passengers.

The last notable German development was a four-car streamliner built by M.A.N. in 1938. Motor trains of this type utilized a single slow-speed diesel engine developing about 1300 hp. at 700 rpm. Because of its size and weight the engine-generator set was mounted in a power car instead of on the trucks. In addition to the power plant and driving cab, the power cab contained baggage and mail compartments. Seats were provided for 126 passengers plus 29 more in a dining section. Like all previous "flyers", the M.A.N. quadruple unit had a top service speed of 97 mph.

French Lightweight Construction

France was probably the most extensive user of railcars and motor trains during the 1930's. From 1932 to 1935, inclusive, the number of autorails, or automotrices, in operation grew from less than 30 to 337. By 1938 this figure had increased to 700. The average daily mileage traveled by railcars rose from 2,480 in 1932 to 42,565 in 1935, and in 1938 they were averaging almost 90,000 miles per day, or 23 per cent of all passenger train mileage.

Railcar development was more diversified in France than in other countries, both in application and in construction. The French railways utilized railcar service over every principal line, and extensively into the intermediate, connecting, branch and feeder lines as well. In many cases they replaced steam trains, providing faster and more frequent service. Railcars were also used at ports of call when ocean liners did not land enough pas-

sengers to justify the use of large express trains.

As for their effect on traffic receipts, experience indicated that if railcars were merely substituted for steam trains in corresponding numbers there was little increase in traffic, but the decrease in operating costs represented a substantial profit. However, if at least two railcar trains replaced each steam train withdrawn, there was an increase in passenger revenue. The operating costs of the best French diesel railcars were found to be about half the costs of the steam trains they replaced.

Lightness was the dominant factor in French railcar construction, not only because of the higher speeds possible, but because of resultant lower operating costs and reduced maintenance of permanent way. According to M. Victor Nicolet, Assistant to the Chief Mechanical Engineer of the French State Railways, railcars with an empty power-weight ratio of 15 hp. per ton were the most desirable for general service in order to prevent overloading of the engines and to assure approximately 60,000 miles of service between overhauls. Mechanical transmissions were believed to be the most satisfactory because of their light weight, reliability and economy.

An important feature of all Bugatti railcars was their very high horsepower per unit of weight. Fully loaded, the power-weight ratio varied from 10 hp. per ton for the three-car train to 19 hp. per ton for the single 300-hp. unit.

French Postwar Development

At the beginning of the war in 1939, the French National Railways owned approximately 300 railcars. Due to the war this number declined rather abruptly. Various estimates have placed the amount of decline at between 25 and 50 per cent.

In March, 1947, the management of the French National Railways adopted a policy for future railcar procurement which provided for two main classes. Intended for branch lines, the cars in the first class were to be of relatively small capacity with moderate power-weight ratios, but able to haul a light trailer. Cars in the second class were to be of more powerful construction and able to maintain higher start-to-stop speeds than steam trains, even when hauling trailers. Cars in both classes were to have diesel engines and mechanical transmissions exclusively.

The cars were to be used to make fast cross-country connections where the steam services were not convenient, and also to provide pick-up services along the main lines in connection with the trains stopping only at large cities. The cars also were intended to provide service during mid-day where morning and evening peak traffic was handled by steam trains, and were to replace steam trains on lines of very light traffic. Under this program the French railways planned to build 400 railcars and 500 trailers in the following ten years.

Railcar Services in Italy

In Italy, railcar traction on a large scale began towards the end of 1933. This trend continued throughout the 1930's, during which time Italy became one of the leading users. From only a handful of cars in 1930, the number rose to 95 in 1934. By 1938 there were 579 in service, and when Italy entered the war the figure was approximately 700.

Unlike those of France, Italian railcar designs were fairly well standardized during the 1930's. The existence of only two large railcar builders, the Fiat Company and the Breda Company, tended to reduce the variety of basic designs.

The standard Fiat and Breda single cars each accommodated 56 passengers and had a loaded weight of approximately 29 tons. The Fiat cars were used mainly for other than high-speed services and were of two types; one with two 80-hp. diesel engines and the other with two 115-hp. units. An engine and a mechanical transmission were mounted on each truck, giving the cars a top speed of about 68 mph.

The Breda cars were used mainly for high-speed services and were powered by two 115-hp. diesel engines equipped with hydraulic transmissions. One engine - transmission set was mounted on each truck, giving a top speed of 87 mph.

Up to 1937, almost all of the railcars on the Italian State Railways were designed for solo operation only. However, the increasing popularity of these vehicles led the railways to equip all subsequent cars for multiple-unit operation. For the same reason, a number of three-car articulated motor trains were placed in service. Built by Fiat in 1936, each triple-car set was powered by two 450-hp. Fiat V-12 diesel engines equipped with mechanical drive. Air-conditioned throughout, the trains carried 78 passengers each, and were equipped with kitchen facilities. Each unit weighed 95 tons empty and 106 tons loaded. Designed especially for high-speed main-line service, the trains had a maximum speed of 100 mph.

In 1936, railcars in Italy were covering an average of 13,000 miles daily. In the summer of 1939, the daily mileage had risen to 73,000 including several mile-a-minute services. Over an entire year railcars accounted for 22 per cent of the total passenger train mileage. The daily mileage per railcar varied from 45 to 436 miles, the average being about 126 miles per day.

In 1938, the operating cost of a single-unit railcar operating in traffic other than high-speed services was found to be 3.78 lire per mile, including maintenance, repair and depreciation. The operating cost of a steam locomotive with two coaches was 7.92 lire per mile, or over 100 per cent more than that of the railcar. In high-speed service, railcar costs were only about 32 per cent of those for steam trains.

Motor Trains of the Low Countries

In the low countries of Denmark, Belgium and Holland, the decade of the 'thirties was marked by the appearance of a number of outstanding motor trains. Patterned after the "Flying Hamburger", these two and three-car diesel-driven trains provided frequent, high-speed service between the more important cities of those countries. Branch-line and local traffic was handled mainly with single-unit cars of either two or four axles, equipped with diesel-mechanical or diesel-electric power plants.

Netherlands Trains of Unique Design

One of the most widely publicized applications of diesel motor trains during the 1930's was that of the Netherlands Railways. The first important development came in 1934 when 40 three-car motor trains were placed in operation at approximately the same time. These high-speed streamliners were placed on the central main lines (Amsterdam - Utrecht - Eindhoven and Rotterdam-Utrecht-Arnheim), providing good connections at various junctions in addition to rapid travel between terminals.

The triple-car sets were articulated, and carried 164 passengers on a gross weight of 108 tons. Multiple-unit control was incorporated so that two or more sets could be coupled together and driven by one man. Two diesel-generator sets were mounted in the center car, and the traction motors were carried on the articulation trucks which were of the six-wheeled type.

Of the 40 trains, 35 were powered by two Maybach 410-hp. engines of the type used in the "Flying Hamburger", and five by two 400-hp. Stork-Ganz engines. The cars were built by Werkspoor in Holland and the electrical equipment was supplied by Brown-Boveri in Switzerland.

The second factor causing these trains to receive wide attention was a series of engine breakdowns which took place shortly after the trains were placed in service. The trains affected were the 35 units equipped with Maybach engines. The five trains powered by Stork-Ganz engines continued to operate quite satisfactorily.

The Maybach-engined trains were withdrawn from service and a thorough investigation made to determine the cause of the trouble. According to a statement issued by the Netherlands Railways, the chief causes of the failures were excessive vibration of the crankshaft, an irregular fuel supply and improper lubrication. These defects were soon remedied and the trains restored to service.

Following the extensive application of diesel railcars and motor trains by the Netherlands Railways, an observed increase in traffic took place. The resultant faster, more frequent service succeeded in drawing traffic not only from the buslines but also from private automobiles.

To supplement the work being performed by the triple-car sets, the Netherlands Railways in 1940 acquired 18 five-car diesel-electric trains of 1950 hp. each. The newer units were of the same basic design as the earlier ones except for the number of power plants. The five-car trains carried three Maybach-type diesel engines in the power car instead of two. In addition, all three were supercharged to provide 650 hp. apiece, or 1950 hp. per train. The newer, five-car sets had a top speed of 100 mph. as compared to 86 mph. for the three-car units.

In 1938 a cost comparison was made between one of the three-car diesel-electric motor trains and a steam-driven train consisting of a locomotive and four coaches. The cost of operating the motor train was 0.61 guilders per mile as against 1.30 guilders per mile for the steam train, a reduction of about 54 per cent.

Other European Users

Self-propelled cars and trains were used in almost every country in Europe during the 1930's. In addition to those countries previously discussed, railcars were being operated in the following:

Austria	Jugoslavia
Bulgaria	Norway
Czechoslovakia	Poland
Estonia	Rumania
Finland	Spain
Great Britain	Sweden
Greece	Switzerland
Hungary	Turkey

Unique Applications in South America

As late as 1947, South America's railroads were still far from adequate to meet the needs of the Continent's economy. Except for certain regions, such as the areas around Buenos Aires, Sao Paulo, and Rio de Janeiro, railways were relatively few and scattered. The factors creating this condition were numerous and complex. Poor climate, rugged topography, shortage of capital, and shortage of fuel were among the major difficulties.

Most of the lines were built by various foreign interests without inter-line connections or uniformity of gauge. A railway-equipment industry was practically non-existent. The development of railway passenger traffic was minimized by lack of proper equipment and intense competition from the highways. There was, however, considerable progress on the more ideally-located railways.

Beginning in the early 'thirties, a number of countries adopted diesel vehicles on their lines. The economy, light weight and performance of diesel railcars, or *autoferros*, made them particularly suitable for use on various South American lines. Leading in the application of this equipment were Argentina, Brazil, Colombia, and Peru.

Argentine Suburban Motor Trains

The largest application of railcars and motor trains in South America during the 1930's and early 1940's was to be found in Argentina. The number of vehicles in service rose from only 21 in 1934 to 310 in 1940, steady progress being made on nearly all railways.

Diesel railcars were applied to branch-line, mainline and even suburban service with considerable success. Although steam trains were retained on many lines, some were being operated entirely by railcars. A typical example was the Buenos Aires-Capilla del Senor route of the Central Argentine Railways. After the steam trains were replaced by railcars, the daily mileage rose to 1086, an increase of 34 per cent.

On the B.A.G.S., a large portion of the railcar operations were confined to suburban and outer-suburban service around the Argentine capital. The inauguration of railcar service in 1938 enabled the B.A.G.S. to increase its total suburban train mileage by 5 per cent, at a time when steam-worked suburban mileage had decreased by 19 per cent. On one route the train frequency jumped almost 40 per cent, an increase quite impractical with steam operation.

These suburban cars were all single units built by Drewry, and powered

by 100-hp. Gardner diesel engines equipped with mechanical transmissions. Each car carried 39 passengers in addition to baggage and mail. Multiple-unit control was a feature, enabling trains of one, two or three cars to be operated by one man. (Triple-car trains accounted for two-thirds of the suburban mileage on the B.A.G.S.). Similar Drewry cars were used on the Buenos Aires Western, Entre Rios and Argentine North-Eastern Railways.

In 1940 almost 40 per cent of the route mileage of the Argentine State Railways was being served by railcars. All 94 of their broad, standard and narrow-gauge railcars were being built by Ganz, including both single and triple-car units.

In 1941 the Buenos Aires Pacific was using a number of Ganz single cars on their 660-mile trans-Argentine line connecting Buenos Aires with the Mendoza-San Juan area. These 300-hp. diesel units had either hydraulic or mechanical transmissions, and a service speed of 62 mph. Each car carried 60 passengers on a total weight of 39 tons. Multiple-unit controls were incorporated in all the cars.

The 320-mile, narrow-gauge Buenos Aires Midland Railway achieved notable success with a number of British-built twin-car sets in both local and main-line service. Each car carried two 102-hp. Gardner diesel engines and mechanical transmissions. The local trains had 90 seats and the main-line sets, 72, plus kitchen and dining facilities. Both types were built by Birmingham, and fully loaded, weighed about 41 tons each.

Twin and Triple-Car Sets in Brazil

Although a number of single-unit railcars were in operation in Brazil, the accent seemed to be on units of two and three cars. As in Argentina, a large portion of the Brazilian vehicles were of English manufacture, the principal suppliers being Walker and Armstrong-Whitworth. The balance were either of German or Italian make.

In 1934 the Sao Paulo Railway began operating their first motor train, "La Cometa", between the port of Santos and the City of Sao Paulo, a distance of 49 miles including the Serra incline worked by cable. The 450-hp. diesel-electric unit was built by Armstrong-Whitworth and consisted of three cars. It had seats for 168 passengers plus a 19-seat lounge-buffet section, and weighed approximately 104 tons empty.

In 1939, this deluxe service was augmented by two four-car, 600-hp. trains of similar design. Named "Estrella" and "La Planeta", the larger units carried 134 passengers, including twelve in a special lounge-observation section, and weighed 121 tons empty.

The Sorocabana Railway was running two triple-car motor trains over the 220-mile Sao Paulo-Botucatu line in 1942. The grades on this route are as steep as 2.5 per cent, and the line rises to 3200 ft. above sea level. Both trains were German-built and equipped with horizontal Deutz diesel engines, two 275-hp. units being used for each train. Power was transmitted to the wheels through a five-speed mechanical transmission.

Seats were provided for 112 passengers plus an additional 22 in a dining section. Built of high-tensile steel, the trains had an empty weight of only 78 tons. A top speed of 68 mph. was allowed, and up grades of two per cent, a speed of 35-37 mph. was maintained.

In the same year, the Central Railway was using five twin-car trains built by Fiat. Running between Rio de Janeiro, Sao Paulo and Bello Horizonte, these articulated units had a top service speed of 55 mph. and could maintain a speed of 30-33 mph. up ruling grades of two per cent.

Power for each set was furnished by two 145-hp. Fiat diesel engines driving through mechanical transmissions of the same make. Air-conditioned throughout, each train had seats for 60 passengers, a bar, baggage space, three washrooms and two engine rooms within a length of 99 feet.

Colombian Trains With Hydraulic Drive

The Colombian National Railways in 1946 reported the following stock of autoferros and trailers:

14 "De Luxe" ACF motor cars; average capacity 40 passengers
8 "Standard" ACF motor cars; average capacity 43 passengers
10 small motors cars; average capacity 8-26 passengers
13 trailer cars, ACF design; average capacity 50 passengers

While this is not impressive when compared with railcar equipment of many other countries, it is of special interest for several reasons. First, the majority of the cars were equipped with hydraulic drive; and second, operations included some stretches of track in the Colombian Andes having very steep grades.

The line from Ibague to the capital city of Bogota involves a climb from 1049 ft. above sea level at Girardot on the Magdelena River to 9004 ft. at El Chuscal, all within a distance of 78 miles. The grade ranges from 4 per cent to 4.6 per cent for 42 miles between San Joaquin and El Chuscal requiring the cars to be driven continuously by hydraulic torque conversion over this stretch.

Railcar services were provided in 1947 on a number of lines radiating out of Bogota and likewise running northward and southward from Cali. Quite a large proportion of the railroad lines provided autoferro passenger service.

The difference in speed as between the two types of passenger service was much greater in the fairly level Cauca River valley north and south of Cali than in the mountain territory around Bogota.

Even though faster than steam trains, the Colombian rail motor cars were run at rather low average speeds by modern standards. For the run from Ibague to Bogota of 155 miles the average speed was less than 30 mph. including 22 stops en route. From Cali to Popayan, 100 miles with eleven stops en route they averaged only about 27 mph. Furthermore, the motor cars apparently were inadequately powered for heavy grade service. Even without a trailer their maximum speed up the 4 per cent grades was only about 20 kilometers (12 miles) per hour on track where curvature permitted a speed of 40 kilometers per hour.

The 22 motor cars in the so-called

"De Luxe" and "Standard" categories each had a loaded weight of 21.4 tons. The trailer cars weighed 20.5 tons loaded. The power plant housed under the floor of each motor car was a 275-hp. horizontal Waukesha-Hesselman oil engine with electric ignition. Thus the power-weight ratio of a motor car-trailer combination was approximately 5 hp. per ton.

Interviews with officials of the Colombian National Railways, on a visit to Bogota in December, 1947, revealed the fact that the original power plants in these cars were inadequate and subject to frequent breakdowns. In December 1947, some were being replaced by Cummins diesel engines rated at 275 hp. Doctor Manuel Mantilla, Chief Mechanical Officer, stated that the hydraulic drive feature in the cars had given generally satisfactory performance. This was a Twin Disc hydraulic torque converter, similar to those installed in the motor cars built by American Car and Foundry Company for the New York Susquehanna and Western and several other U. S. railroads. The torque converter contained two elements — hydraulic for acceleration and heavy grades, and direct-drive, for coupling the engine directly to the drive axle for operation at higher speeds and on lesser grades.

Peruvian Railcars on Steep Grades

In 1938 the Peruvian Corporation began a policy of replacing steam traction by diesel motor cars. Lightweight, self-propelled vehicles were found to be far less costly and considerably faster than steam trains in mountainous country. Some excellent results were achieved on the Central Railway where extremely steep grades and numerous curves had to be negotiated.

The Central of Peru is a standard gauge line running from Lima to Oroya and Huancayo, a distance of 209 miles. Climbing over the first range of the Andes, it reaches a point 15,694 ft. above its starting point in 100 miles. This is a gradient of about 3.3 per cent. In addition, the rarefied air at high altitudes reduces the power output of internal combustion engines approximately one per cent for every 300 feet of altitude.

One of the first successful railcars used was a 200-hp. articulated unit built by Walker Bros. in 1939. Used on the Callao-Oroya route, this car carried 40 passengers on an empty weight of 27 tons.

Probably the most interesting operation was that of two supercharged diesel-mechanical railcars which began in January, 1948. The upgrade distance of 118 miles between Lima and Oroya was covered with a single car in 4 hours and 33 minutes, and with two cars coupled together it took only 4 hours and 36 minutes. This running time was much faster than the 6½ hours required by steam trains and the 5½ hours required by road motor traffic.

Each car had a Saurer diesel engine developing 200 hp. continuously at sea level, and 150 hp. at 15,000-16,000 ft. above sea level. Power was transmitted from the engine to the driving axles by means of a four-speed gearbox and a traction-type coupling. Built by Wickham of England, the cars grossed 23 tons each, and carried 50 passengers.

Usage in Canada, Asia and Africa

In general, Canadian railcar experience may be likened to that in the United States. Although diesel-electric cars appeared somewhat earlier in Canada, both the design and operation of self-propelled vehicles followed similar patterns in the two countries.

Railcar development in Asia and Africa was slower than that in Europe or South America. Railcars and trains were used in various English and French possessions but not to any large extent. Moreover, the vehicles used were of the same designs as those in Europe — Ganz, Renault, etc. The more important applications were to be found in Egypt, Syria, Algeria, India and Ceylon.

Summary

Since 1930 the application of diesel power to railway operations in the United States has emphasized diesel locomotive development. In contrast, dieselization of railway operations in many other countries has been largely embodied in a variety of rail motor cars and motor trains. These developments may be briefly summarized:

1. European rail motor cars built during the 1930's generally had a high horsepower per unit of weight, giving them rapid acceleration and speed.
2. They were used extensively in all types of railway passenger service — mainline through service, branch line and local services. They were economical to operate and their fast frequent service developed traffic on many lines.
3. Lightweight construction, mechanical transmissions, and truck-mounted power plants were widely featured. Capacity of engines ranged from 100 to 600 hp. Multiple-unit controls and hydraulic transmissions were often used.
4. Probably the largest application of diesel rail motor cars in suburban service was in the area surrounding Buenos Aires, Argentina. In 1940 some 100 units equipped with multiple-unit controls were used to provide economical frequent service.
5. Rail motor cars were operating economically over very steep grades and at high altitudes in Colombia and Peru, cutting hours off steam train schedules in mountainous regions.
6. In many countries passengers were required to pay extra fares for the deluxe service of diesel motor trains. Passengers were willing to pay a premium for the improved service.

This is the first of a two-part article dealing with diesel motor trains. The second installment will appear in the March issue and will cover Economy of Operation and The Problem of Railroad Passenger Service and will also give the authors' conclusions.

The authors of this paper wish to express their appreciation for the assistance given them in the completion of their research. Financial assistance was provided by the following: American Car and Foundry Corporation, The Budd Company, Cummins Diesel Motivepower Corporation, Pullman-Standard Car Manufacturing Company and Twin Disc Clutch Company.

Diesel Exhaust Aids Crop Production

by A. N. Anderson*

A FEW years ago, a farmer in Arizona became annoyed at the noise of the exhaust of his diesel irrigation pump engine, so he quieted it down somewhat by submerging the exhaust pipe in the irrigation water stream. Some months later, he was surprised to find a noticeable improvement in his crop of alfalfa. The story was told and other farmers tried the same thing. An inventor, Mr. Carl Sues, from Lancaster, California, whose business actually was selling irrigation pump engines, heard about the experiments of the Arizona farmers and began to seriously analyze the reasons why the exhaust of a diesel engine could possibly improve crop production.

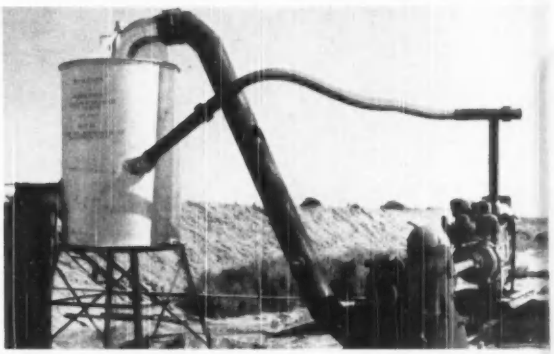
The soil in Arizona and California, and in fact in most of the arid regions of the world, is alkaline in nature, as is also the water pumped from underground to irrigate the land. Most crops grow best in soils which are nearly neutral, that is, neither alkaline nor acid. Mr. Sues concluded that the carbon dioxide and sulphur dioxide formed by the diesel engine combustion process reacted with the irrigation water when the exhaust pipe was submerged, resulting in the formation of small amounts of carbonic acid and sulphuric acid. These acids tended to neutralize the alkaline irrigation water by changing the insoluble carbonates to soluble bicarbonates.

A chemical analysis of the subject led to the conclusion that a rather complicated device would be required to realize a reasonable efficiency of exhaust gas absorption, but that if a device could be made efficient, it would have a very definite value in water and soil acidulation. Inasmuch as sulphur makes up only a very small percentage of present day fuel oils, its effect as a dealkalizer would be of no great benefit. Carbon Dioxide, however, in making up about 9-10 per cent of the diesel engine exhaust would have a very definite value if it could be absorbed in the water.

It so happens that for the average pumping lift of 120 to 130 feet in the Southern California area, the volume of water pumped is about equal to the volume of exhaust gas. Furthermore, at the normal water temperature of about 70 degrees, carbon dioxide is soluble in water in about equal parts by volume. The tremendous quantity of inert nitrogen and oxygen being carried out the exhaust along with the carbon dioxide seriously hinders its absorption. It became apparent to Mr. Sues that only by breaking up the entire quantity of pumped water into minute droplets could a reasonable quantity of carbonic acid be formed. His first trial unit was about 20 per cent efficient, and changed an alkaline irrigation water to a mild acid. Later tests proved that substantially all the carbon dioxide remained in solution and served to decrease the alkalinity of the soil by converting the calcium carbonate in the soil to calcium bicarbonate.

It was also determined that a small but valuable quantity of fixated nitrogen was formed in the combustion process, which actually substantially duplicates commercial practice in the formation of nitric acid. This nitrogen is of course valuable as a fertilizer.

Unfortunately, Mr. Sues did not live to see the full realization of his dream. The device is being patented by his estate, however, and the Anderson-O'Brien Company of Los Angeles is licensed to manufacture the device under the trade-name *"De-alkizer"*. Recent tests have shown a carbon dioxide recovery efficiency of 37 per cent on present production models, equivalent in acidulation value to 400-500 pounds of gypsum or 75-100 pounds of sulphur per acre foot of water. The nitrogen recovery is about 1 pound, or is equivalent to 3.7 pounds of ammonium sulphate per acre foot. With this recovery, the *"De-alkizer"* will pay for itself in less than one season's pumping.

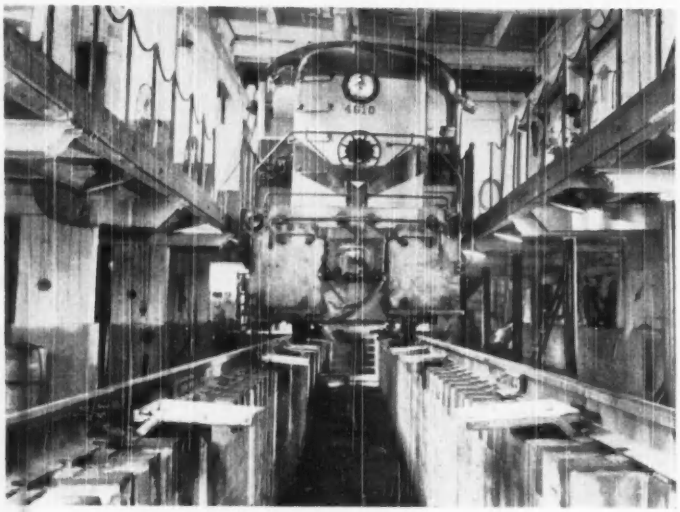


Exhaust from diesel, which drives pump, goes to side of tower. Water is pumped to top of tower and absorbs gases from exhaust which bubbles up through it. Treated water then goes to irrigation tank (far left).

Whereas the present day cost of diesel fuel has somewhat impeded the sale of diesel engines for irrigation pump use, the benefits to be derived from the *"De-alkizer"* in utilizing "free" diesel exhaust gas again places the diesel engine in the position of the most economical power source. The actual exhaust gas recovery may be valued at about $2.75 per horsepower per month based on prevailing prices of gypsum, sulphur and Ammonium sulphate. This recovery would entirely cover the cost of fuel oil selling at 6 cents per gallon.

Anderson-O'Brien Company, Los Angeles, California

DIESEL BRIEFS



"Hotfoot" for Locomotives

At the Detroit and Mackinac Railway's diesel locomotive repair and maintenance shops, Twin City, Michigan, blasts of heated air are discharged on locomotive undercarriages to melt off ice and snow. The air is transported through ductwork from a Dravo "Counterflo" Heater to the repair pit. The same heater also helps maintain comfortable temperatures for employees. A total of four oil-fired Dravo heaters are used for the entire repair shop.

A.E.R.A. 1950 Convention

Definite plans for the 1950 Convention of the Automotive Engine Rebuilders Association have been made with the New Jefferson Hotel at St. Louis, Missouri. The technical session will convene for three days, May 18-19-20.

All hotel reservations will be made through A.E.R.A. Headquarters at Indianapolis. This activity will begin soon when the necessary reservation forms will be mailed to all Association members and invited guests.

Snap-On Expansion

Announcement of the expansion of distribution and production facilities of Snap-on Tools of Canada, Ltd., was made recently by A. W. Clark, general manager.

Plans for a Snap-on general office and factory to cover approximately twenty-thousand square feet are being drawn up. It is expected that construction will be completed in 1951.

A seventh Canadian branch, located at Regina, Saskatchewan, was opened January 3 to serve the increased demands for Snap-on service in western Canada. Other branches are located at Vancouver, Edmonton, Winnipeg, London, Toronto, and Montreal.

G-M Sells Kinetic Interest

General Motors announced recently that negotiations have been concluded for the sale of its interest in Kinetic Chemicals, Inc., to E. I. du Pont de Nemours & Company. These negotiations have been under way for nearly a year.

Final consummation of the sale now awaits action by the Securities and Exchange Commission upon an application filed by the Du Pont Company for permission to purchase General Motors holdings in Kinetic. Approval is required under the Federal Investment Company Act of 1940. The sale price agreed upon was reported as approximately $9,700,000.

SAE President

James C. Zeder, Chairman of the Engineering Board of Chrysler Corp., has been elected president of the Society of Automotive Engineers for 1950. Zeder rose to his present position at Chrysler when its Engineering Board was first formed in 1946, having previously been chief engineer of all Chrysler laboratories since 1933.

During World War II, he conceived and stimulated organization of the SAE War Engineering Board, major war service agency of the Society of Automotive Engineers, and served as its chairman for six years. A graduate of the University of Michigan, Zeder holds an honorary doctor's degree from the University of Dayton.

British Industrial Visitors

Studies of American methods and techniques of designing and manufacturing diesel locomotives were begun Jan. 10 with the arrival in New York City of a group of representatives of the industry in Great Britain, the Economic Cooperation Administration announced recently.

The technicians and workers are making the study as one of a series of technical assistance projects designed to aid in increasing the production of British industries. The visits are sponsored jointly by the Anglo-American Council on Productivity, the British Government and ECA.

During 1949, 11 productivity teams and three specialists groups from the United Kingdom made studies in this country. The locomotive team is the first British group scheduled for arrival in 1950. Two other industries sent teams to the U. S. last month and about 40 more groups are scheduled to arrive during the year under the pro-

DIESEL BRIEFS

gram announced by the Anglo-American Council on Productivity.

Sheppard Sales Aid

The R. H. Sheppard Company, manufacturers of Sheppard diesel tractors and farm implements, is offering its dealer organization a new sales aid in the form of a miniature model of their SD-3, three-plow tractor. The miniature tractor is reproduced to scale at approximately 1/16th size. The model row crop tractor is mounted on rubber wheels and is finished in the standard Sheppard orange with the name and model imprinted in black on the sides of the tractor.

Oil Film Study

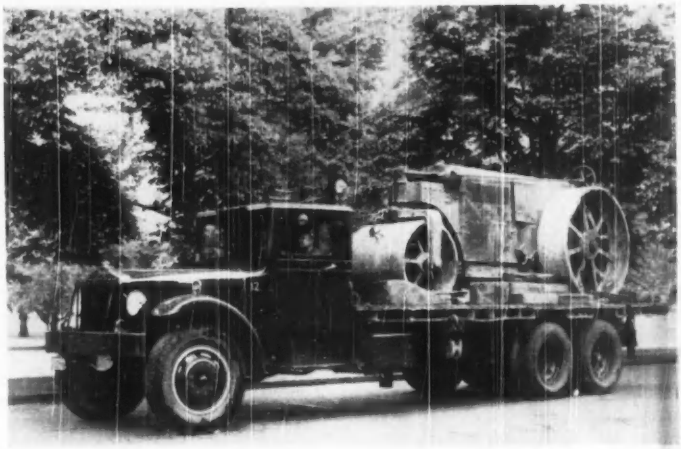
Engineers of the California Research Corporation at Richmond, Calif., are "taking the fingerprints" of oil surface films as thin as two-millionths of an inch in studies which may lead to development of new and improved lubricants.

They accomplish this by using a device, developed by General Electric Company engineers, called the "electron diffraction instrument". This device "fingerprints" a specimen lubricant by showing a pattern which is formed by electrons diffracted from the lubricant's surface. Every surface has its own electron diffraction pattern, and by studying a specimen's "fingerprints" made by its diffraction pattern, engineers can determine the exact nature of a surface, it was explained.

A-C Retirement Plan

The Allis-Chalmers Manufacturing Company is preparing a proposed retirement plan for all of its 30,000 employes, it was announced recently by the company.

In addition, the company is studying improvements in its health and accident plan recently suggested by the West Allis works Mutual Aid Society. The mutual aid societies are operated locally at each plant, with the company matching employe's contributions.



Truck Pioneer

This 11-year-old Sterling flatbed pioneered the dieselization of the heavy-hauling industry in the area around Pittsburgh, Pa. Crane and Truck Service, Inc., owns the vehicle. The unit is powered with a 150 hp. Cummins Diesel, and the original engine is still in service. Currently, the heavy hauler is working in the Knoxville, Tenn., region. Three Cummins-Powered Sterling and Diamond T heavy haulers in the Crane and Truck Service fleet average from eight to ten miles to the gallon of diesel fuel.

The combined initial annual cost of the two programs, with other insurance benefits now in effect, was estimated to be approximately 11 cents per pay roll hour or between $6,000,000 and $7,000,000.

Power Cost Survey

A Report on Oil Engine Power Cost for 1948 has recently been published by the ASME. The report, prepared by the Subcommittee on Oil-Engine Power Cost, Oil and Gas Power Division, ASME, also includes a diesel locomotive supplement for the first time.

Divided into three tables and containing three graphs, the report covers such items as total installed bhp., total net output kwh., annual load factors, and costs of fuel, lube oil, labor, and other costs as well as several other items. Information used in the survey was gathered from a total of 124 plants operating a total of 441 engines. The number of plants reporting represents an increase of seven over 1947.

The subcommittee, headed by H. C. Major, Chairman, operates as a fact-finding committee and does not attempt to establish conclusions or interpret the data recorded in the report. The report may be obtained from the ASME for $2.50; members receive a 20 per cent discount.

Tube Turn Plant

Tube Turns of Canada, Ltd., which was granted its Dominion charter on December 2nd, is establishing a modern plant in Chatham, Ontario. The company will manufacture Tube-Turn welding fittings.

Preparations are now being made for the installation of special machinery and facilities, and operations will start in about three months.

Tube Turns of Canada, Ltd. is a subsidiary of Tube Turns, Inc., Louisville, Ky.

Valve, Ring, Cylinder Sleeve, And Other Designs As Aids to Lubrication

By A. T. Colwell and A. L. Pomeroy*

OIL technicians are striving to meet the requirements of modern engines, which are constantly increasing the loads on the lubricant by higher specific output and longer life expectancy of the power plant. The lubricant is asked to prevent scuffing and abrasion; to minimize wear and corrosion; to reduce friction and to act as a coolant. In performing these functions, it should not deteriorate too rapidly, be expended in excessive quantities, or leave harmful deposits in any part of the engine. This is a large order; somewhat, in fact, like the search for the perfect solvent, which would dissolve anything with which it came into contact, but would present the new problem of finding a container in which it could be kept.

Tremendous and satisfactory progress has been made. The engineer and metallurgist, however, can greatly assist the oil technician by intelligent design, and this paper is presented to indicate some of the methods of approach. Two distinctly new proven products, a piston ring and a valve rotator, should be of help to the oil technician; and a new cylinder-sleeve design shows considerable promise in the development stage. The present oil problem is closely analogous to the valve-steel problem: to obtain a necessary increase in oxidation and corrosion resistance, more nickel and chrome were added to the steel; but at a higher alloy addition, the steel became austenitic, could not be hardened, and had a higher coefficient of expansion; thus additional problems were born in solving the original difficulties.

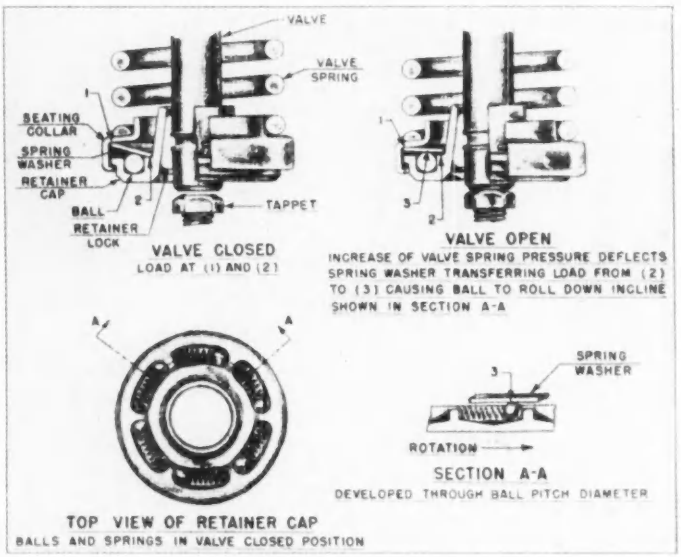
Valves

The greatest percentage of burned valves is definitely caused by sticking or sluggish operation, and by deposits chipping from the seat of the valve. Sufficient test data are now available to state that valve rotation increases exhaust valve life from two to five times. In some engines there is intermittent valve rotation due to forces inherent in the design. However, it is erratic and unreliable, and it is necessary to use rotator devices to obtain satisfactory rotation. This rotation may be accomplished by the positive rotating *Rotocap*, or the non-positive *Rotovalve*. Rotating the valve tends to keep the stem and seat clean of deposits, and to prevent tip gouging.

In case of block-seat distortion, the gradual rotation prevents excessive heat on the valve at the area of distortion. No valve material known today will last long if blowby occurs at a gutter or open area, because of the blowtorch effect. There is a trend toward hard-faced valves where rotation is used, particularly with the non-positive type rotator.

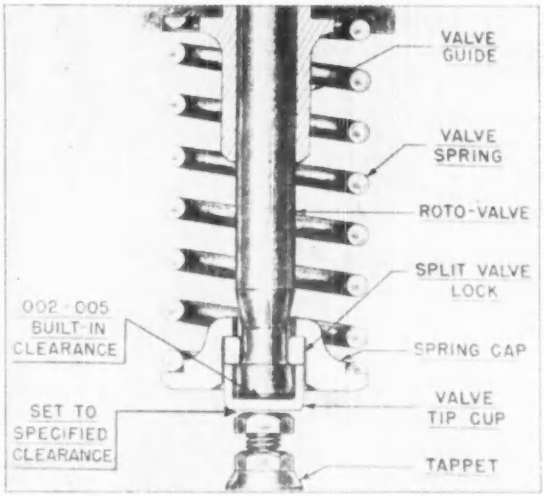
Certain of the additives used with some compounded oils have been found to produce deposits causing a reduction in valve life. This may become a more serious problem since there is a trend to higher percentages of additives in heavy-duty oils. The illustrations indicate that valve rotation contributes greatly to solving this problem, and this is of particular interest to the oil technician.

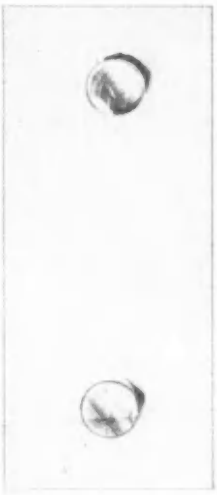
The higher the valve temperature,



Positive valve rotator—the Rotocap—showing details of construction and operation.

*The authors are, respectively, Vice-President and Staff Engineer, Thompson Products, Inc. Abstract of a paper presented to a Lubrication Group Session, 29th Annual Meeting of the American Petroleum Institute at Chicago, Ill. November, 1949.

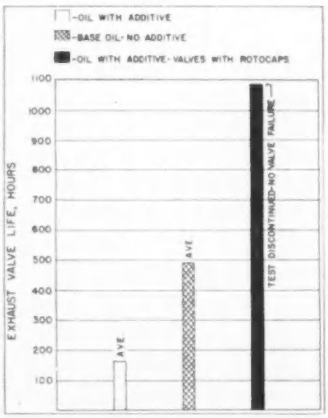




(Left) Non-positive valve rotator—Rotovalve—with construction details and (right) examples of tip gauging which is prevented by the use of the Rotovalve or Rotocap.

the more likely there will be difficulties due to oil deterioration, particularly valve sticking. There are several routes to cooler valves, and sodium cooling is the most effective and has been widely adopted in the aircraft field. Two sodium-cooled designs are available, the hollow stem and the hollow head.

Engine design can be an important factor when using sodium-cooled valves, as the valve guide must be able to dissipate the additional heat carried to it by the sodium; otherwise excessive guide wear and valve-stem coking will follow. Properly designed ports and adequate cooling give excellent results; excessive guide wear reduces heat transfer and induces earlier failure.



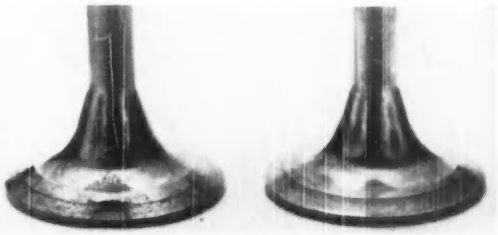
A comparison of good and poor port designs is illustrated. The temperatures shown are actual test results on parts closely approximating those shown, and a special valve material was used for the temperature check. The revised porting reduced valve-stem temperatures from 900 deg. F to 600 deg. F. This improvement is reflected in less deterioration of the oil in the guide area and also alleviates valve sticking.

The designer can use selective cooling to get optimum operating temperatures as an aid to good lubricant performance. Non-uniform cooling can rapidly stress both engine parts and the lubricant. An accompanying diagram shows valve seat insert temperatures as measured in our laboratory for a truck engine. Such high temperature gradients cause distorted seats which, in turn, impair heat transfer from the valve head, thereby resulting in overheating, with subsequent oil deterioration and deposit accumulation.

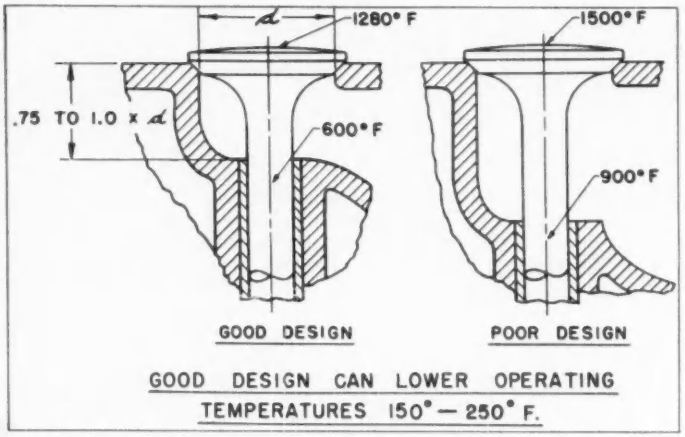
Of primary importance to good engine design is some reliable means of controlling the amount of oil supplied to the valve stems. Inadequate oil at this point will lead to stem scuffing and guide wear, whereas too much oil will invariably cause high oil consumption and deposit formation. Ordinarily, the problem is one of metering the oil to the valve stem. There are several methods for accomplishing this, some of which are illustrated.

Piston Rings

Lubricant performance is definitely influenced by piston-ring design. The most novel piston-ring development of the last twenty years is considered to be the flexible steel "U-Flex" ring. It is now used as original equipment by International Harvester, Buick and Nash. The ring as made is longer than the bore circumference, and on installation, the ends butt together. The 0.007- 0.010-in. gaps (or slots) between each U-segment are compressed to about 0.001-in. when installed, thus creating a uniform outward pressure



Exhaust valve tests on compounded oil (left) and (right) valves after 215 hours, no rotation (left) and after 1,086 hours using a Rotocap.



Comparison of good and poor part designs. The decrease in valve stem temperature is reflected in less deterioration of the oil in the guide area and alleviates valve sticking.

against the cylinder wall, giving a polar diagram which closely approximates a circle. This gives superior oil sealing properties, and the flexing of the ring in operation tends to greatly extend the time of plugging, particularly with the generous oil drainage area available.

The flexibility also allows the ring to conform to out-of-round bores. This is a new principle of oil control which gives high oil mileage without starving the cylinders. The tiny slots serve to meter a controlled quantity of oil to the upper rings and cylinder walls, the ring being designed for each engine to obtain this control, since it is possible to vary the slot width as desired. The ring is hardened all over to Rockwell C 50, and is lighter than conventional oil rings.

Engine overhaul periods are frequently established by increased oil consumption, and laboratory and field data indicate that where this is the governing factor, length of overhaul periods is increased by at least 50 per cent with this new design. Bore life is also extended by the metered lubrication.

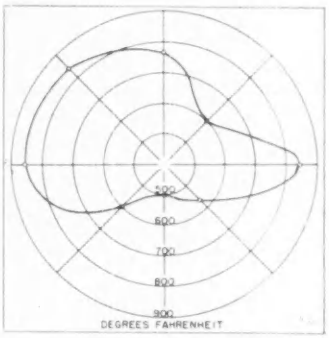
Chrome-plated cast iron compression rings show superior wear resistance, and are being more widely used. Bore wear is also appreciably reduced.

The engineer must help the oil technician to prevent ring sticking. In one test, sticking was prevalent when piston ring belt temperatures went to about 500 deg. F, but there was complete freedom from sticking below these temperatures. Oil cooling of pistons can help, but oil deterioration must not be accelerated. Thinner and deeper compression rings help with higher bmep., and the keystone ring has been beneficial in aircraft engines (*and some diesels—Ed.*). There is considerable basic research yet to be done on temperatures and design which should be of great value to the entire industry.

Pistons

It is a fact that high oil consumption and high wear—of pistons, rings, and bores—accompany each other. Tests have indicated that piston-skirt clearance is important, and that more wear occurs with increased piston-skirt clearance. This increased wear is likely a function of piston slap. The minimum clearance possible without scuffing should be used, and the fit should be held over a wide range of operation with good concentricity. Higher specific outputs are making this problem more acute.

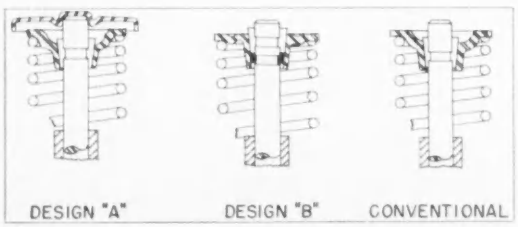
In developing pistons for supercharged diesel engines, some cases of piston seizures at high loads have been reported. A serrated finish on the rubbing surface has helped this condition. This knurled finish provides tiny valleys which act as reservoirs for oil, thereby assisting lubrication of the pistons, rings and bores. A Cummins diesel piston designed by Zollner is illustrated.



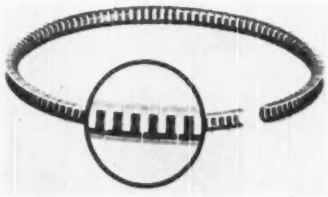
Valve seat insert temperatures for a truck engine.

Electro-deposited and immersion-deposited coatings on new engine parts assist break-in and prevent initial scuffing. Any application which prevents local welding and scuffing, and avoids excessive wear during initial use of a new engine is valuable. Data obtained from a cross-country fleet operating at high engine speeds shows that cylinder wear rate is relatively high for the first 10,000 miles. Because of this condition, designs and oils inhibiting against rapid initial wear are the subject of much study.

In some heavy-duty, high-speed engines, severe ring-land wear has been experienced with aluminum pistons, due to inertia forces developed by the rings, and this is aggravated at high temperature. One solution to this prob-



Methods of metering oil to the valve stem.



U-Flex oil control ring.

lem is a bi-metallic piston with a ferrous metal ring carrier (*see Diesel Power, Jan. '50*) which is cast in place or mechanically attached to the aluminum piston.

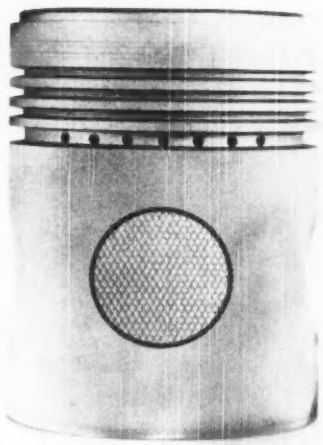
Cylinder Sleeves

Cylinder-bore wear has really plagued the petroleum technician, the scuffing, abrasion and corrosion having as a corollary piston and ring trouble. Extensive work has been done on the cylinder wear problem. These efforts include interrupted surfaces, knurling, coatings, platings, nitriding, and special materials. There has been no generally satisfactory solution. There is a new development under extensive test at the present time which shows exceptional promise. It is the Bramberry Characterized Liner.

This sleeve has reduced wear appreciably in a number of field tests. A "Characterized" pattern is cut into the sleeve, which consists of two sets of helical grooves cut in opposite directions. Each groove has a "V" section and is .005 in. deep, forty to the inch, and the grooves in each set are parallel to each other. This forms a completely interconnected network of grooves and leaves on the bore face an arrangement of diamond-head plateaus.

The grooves are filled with a carbonaceous material which is held firmly in the grooves by a bonding agent. Finally, the sleeves are given a coating which is sprayed on the interior surface to provide protection on run-in.

A number of field tests have been run, and these tests showed impressive resistance to wear and corrosion. The diamond heads are isolated from each other, and apparently a hot spot developing at one location does not spread. The carbonaceous filler in the groove acts as a holder for the lubricating oil in a manner somewhat analogous to self-lubricated parts. The combination of the forces of capillary action and surface tension causes a thin film of oil to be spread over each diamond head. This causes the cylinder surface to be constantly lubricated while using a minimum supply of oil, and undoubtedly inhibits corrosion of the metal.



Knurled piston.

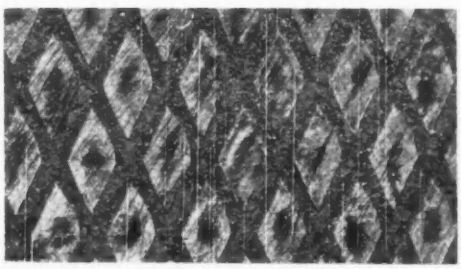
Tests by White Motor indicate that the characterized sleeve is exceptionally beneficial for low-temperature starting, and in other tests it has been found that the sleeve gives good protection against scuffing and abnormal wear. These results are based on a limited number of tests, but have created interest in fully evaluating the design for both original equipment and service.

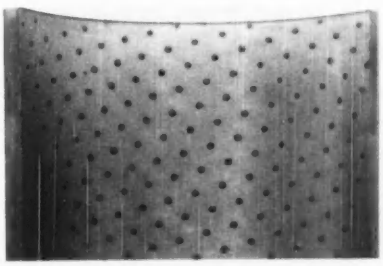
In tests on knurled cylinder bores, the Ethyl Corporation found that knurling in some engines greatly reduced bore wear, particularly in respect to bell-mouthing. Also, knurling somewhat facilitated break-in, but for very quick break-in it was used in conjunction with surface treatments of the "Lubrite" or "Surfide" type.

The value of porous chrome plating in reducing cylinder wear has been clearly demonstrated. Joachim and Payne in their comprehensive investigation showed that the average wear of chrome-plated sleeves in marine service was approximately one-fourth that of castiron. However, the process is considered expensive, and this has somewhat limited its application in commercial service. Monochrome, Ltd., has developed a chrome-plating process in which circular pits are formed in the plating to provide an interrupted surface. Tests have shown unusually good resistance to wear.

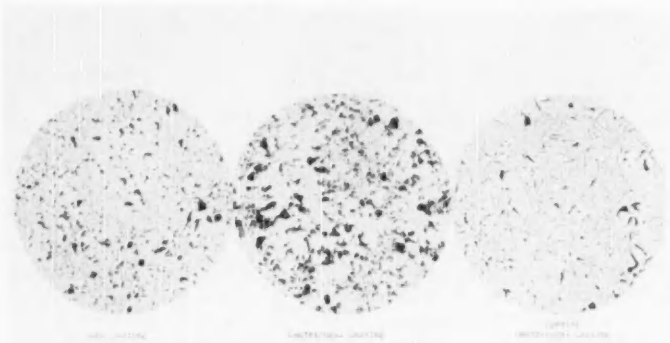
In tests on austenitic materials for liners, considerable improvement in bore wear has been found, but the added cost has discouraged its use. In one test, short austenitic sleeves approximately 1 to 1½ in. long were shrunk into the top of the cast iron bore, and the cylinder was then bored to size throughout its entire length. Material was 15 Ni, 6 Cu, 2.5 Cr, and tests showed top bore wear was reduced 50 per cent. In a British investigation using full sleeves made of austenitic castiron, results showed an improvement in wear of about 2½ to 1, particularly in stop-start operation.

Importance of metallurgy in cylinder wear has shown recently in cer-





(left) Characterized pattern in Bramberry Sleeve (19X) and (right) Monochrome chrome-plated liner



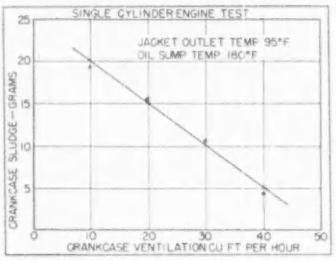
Photomicrographs of (l. to r.) sand, centrifugal, and controlled cooling centrifugal castings.

tain engines where sand-cast liners outwore centrifugally cast liners of the same chemical analysis and dimensions. A metallurgical examination revealed that both had the same matrix structure, but that the sand casting had a predominance of Type A graphite, while the centrifugal casting contained mainly interdendritic graphite. Because of cost advantages, including low machining scrap, it was desirable to use centrifugal castings. By developing a new method of controlled cooling plus careful attention to mold coating, centrifugal castings with the preferred Type A graphite are now being produced.

Crankcase Ventilation

The engineer can help the oil technician by efficient crankcase ventilation. The effect of ventilation volume on sludge formation is shown. Engine design factors will, however, limit the volume of air which can be used. Of the methods tried, the road draft tube is the most widely used. Positive crankcase ventilation, regardless of vehicle speed, can be obtained by using a blower.

Much of the evil influence of inadequate ventilation may be attributed to the large amounts of unburned charge which find their way into the engine crankcase. High-speed photographs of ring motion in an engine with a glass cylinder, taken in our laboratory and in the laboratories of others, have conclusively shown that during the last part of the exhaust stroke, the piston rings move to the upper sides of the grooves, and remain there until the last part of the intake stroke, when they go to the lower sides of the grooves. During this time, there is undoubtedly appreciable blowby of unburned charge into the crankcase.



Effect of crankcase ventilation on sludge.

From analyses of the crankcase gases from conventional engines operated with sealed crankcases, the percentage of CO_2 in the blowby compared with that in the exhaust serves to indicate the degree of burning of the combustion-chamber gases that make up blowby. From these data, roughly one-fourth of the blowby is exhaust products, the remainder being fresh air and unburned fuel. These data further point the need for better piston-ring sealing, particularly during the low-pressure part of the engine cycle.

General

The importance of designing to raise rapidly the temperatures of both coolant and oil to prevent wear is well proven. Pressurized cooling systems and good thermostats are an aid in this problem.

Any change in engine design which reduces the friction horsepower will reduce the amount of heat to be dissipated by the oil, and will reduce the load on the oil provided that there is no appreciable increase in operating temperatures of lubricated parts. One step that appears promising, as far as reducing friction horsepower is concerned, is a reduction of the bore-stroke ratio. The Cadillac engine has adopted a stroke-bore ratio of 0.95 with a material reduction in friction horsepower. High compression ratios increase the thermal efficiency of the engine, as well as allowing a smaller engine. However, peak temperatures and pressures are raised.

Improved fuel distribution, temperature control of manifolds, fuel injection, selective cooling, and oil filters are other ways in which the engineer is attempting to help the oil technician. A self-contained hydraulic automatic tappet, using a synthetic as the fluid medium, would help correct the lacquer and dirt problem now encountered with present types.

Conclusion

The engineer and metallurgist are cooperating with the oil technician to ease his problems. Many definite developments are desired, but the issue is to accomplish them satisfactorily and economically, and new angles of approach may be needed in many cases. Some years ago an engineer was greatly annoyed that he could not open the windows in a Pullman car. Thinking the matter over, he proceeded to air-condition the car, which was an immeasurably better solution. In a somewhat analogous manner, a very definite advance has been made in pistons, piston rings, valve life, cylinder sleeves, engine friction, crankcase ventilation, and general engine design.

These developments are of considerable benefit to the oil technician, who has likewise made great advances in fuel and lubricants. All developments are difficult before they are easy, as the oil technician well knowns, and some of the seemingly smaller problems are the most difficult to solve. But with the combined talent of the engine and oil industries, using their accumulated technical background, many annoying problems are going to be solved at an accelerated rate.

Burlington Introduces Electric Snow Plow

AMERICA'S first electric rotary snow plow designed for use in connection with diesel locomotives is ready for winter service on the Burlington. Railroad men believe it will excel the traditional steam plow in many respects.

The Burlington plow is 16 ft. high, 36 ft. long, weighs 91 tons, and was constructed in the railroad's Denver shops. It utilizes the underframe, trucks, rotor and rotor chute of an old ALCO steam plow, but the cab, carbody, and entire electrical installation is completely new.

The 11½-ft. rotor blades are driven by four electric motors which obtain their current from the diesel locomotive. These motors are identical to the traction motors used on Burlington diesel locomotives, are readily interchangeable, and can be removed from the plow and used in regular service during snowless months.

The cab of the plow, which seats two persons in addition to the operator, is thoroughly insulated and can be kept warm in coldest weather by an oil heater. The operator sits on the right side and immediately in front of him are the controller which operates the rotor, recording instruments, and air-brake emergency valve. He is in continuous telephone communication with the engineer in the locomotive.

The plow body contains the motors and gears to drive the rotor, electrical control cabinet, tool box, and portable kerosene torch for melting snow and ice when required. Both cab and body are snow-tight, and a flush-type headlight is located above the front cab window.

The 11½-ft. rotor, which operates in either direction, turns at 130 rpm. at plowing speed and at 30 rpm. when idling. Being electrically driven, it has constant-speed characteristics, which permit the load to be assumed automatically as the plow advances into a snowdrift.

Burlington snow-fighters believe outstanding advantages of the electric plow will include:

First electric rotary snow plow. The rotor blades are driven by four electric motors which obtain their current from the diesel locomotive.

Ability to operate continuously and over long distances without need to refuel or rewater.

With coal-burning steam plows a good portion of the time is consumed running for water and coal, and in cleaning fires, etc., whereas with an abundant supply of fuel oil and two crews there is no reason why the diesel-electric plow cannot work continuously for a week at a time, if necessary.

Relatively low cost through use of standard diesel locomotive components —motors, gear cases, shafts, gearing, auxiliary generator, controller, etc.— all of which are quickly replaceable from stock in case of damage and all of which can be used in regular train service when plow is idle during spring, summer and fall.

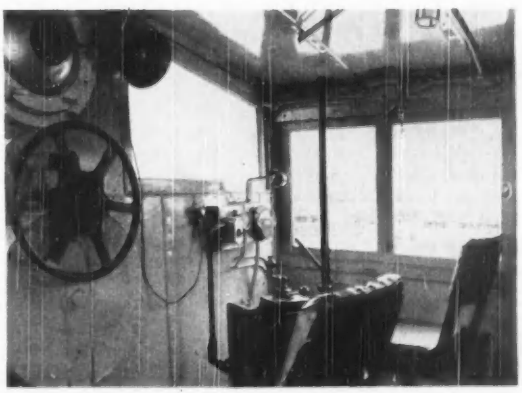
Mechanical and electrical equipment are protected from overload by circuit breakers. Cables connecting with diesel locomotive are completely sealed against weather.

The characteristics of electric power make rotor vibrationless and relatively noiseless. Trucks are equipped with bolster springs for easy riding.

The efficiency of both the electric plow and diesel locomotives are relatively unaffected by severe cold. All vital parts are readily accessible for maintenance and repair on road.

The electrically driven rotor has more torque for cutting ice and more horsepower for plowing snow faster.

Plow can be hooked up and be ready to go in 30 minutes. The power and control cables enter the locomotive through the headlight port.



Interior of the new snow plow. Speaker at upper left center and attached microphone give continuous communication between plow operator and locomotive engineer.

Additives Can Improve Efficiency and Reduce Maintenance

SOME years ago, the subject of the use of additives in fuel and lube oils could always be depended upon to start an argument. There were always those who were for or against such usage and both sides would frequently call upon personal experience to bolster their claims. And there is some justification for each side. There are any number of factors to be considered with the result that, lacking such consideration, there was no common meeting ground.

In the first place, the term "additives" is all-inclusive and gives no clue to the type or function of the compound that was added to the fuel or lube oil; secondly, there are additives and additives; some did a good job whereas others were of little value. Then, there are the cases where an additive performed one function only to cause other difficulties. An example of this might be one that would have good detergent or solvent qualities but, on the other hand, would contribute to acidic build-up and subsequent corrosion.

Take the case of the operator of a large, slow speed engine operating well within its designed load and speed range. He would be inclined to poohpooh the idea of additives for the very good reason that he probably doesn't need them. There is another angle, though, that will be mentioned later.

Now, let's talk about the man that runs a high speed high output engine or the fellow with the engine that is running most of the time at full capacity with frequent overloads. In both cases the lube oil takes quite a beating and as a result will rapidly deteriorate and produce harmful components. These fellows will be more inclined to go along with the additive idea since carbon and sludge deposits, stuck rings, corroded bearings, etc., are costing them money in time and labor.

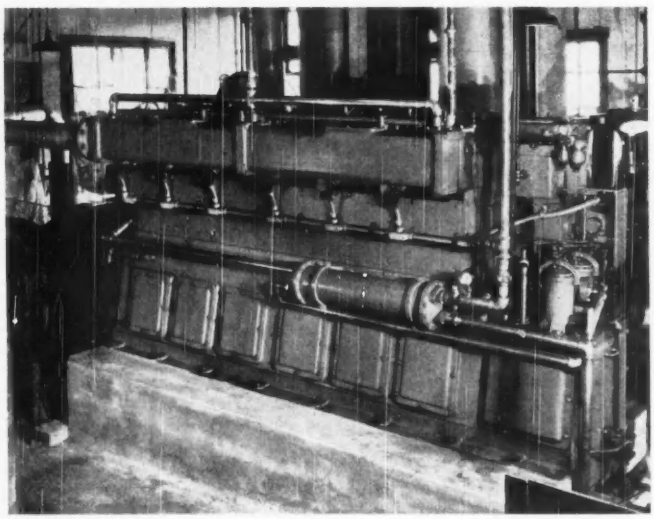
Obviously, viewpoints would differ in any discussion of additives unless all the factors were considered. Remember, we are talking about a period some time ago before engine developments and greater severity of service required the development of the heavy duty or additive type oils. Various additive compounds were placed on the market and were blended with straight mineral oils. The effectiveness of these products also left room for argument and many fell by the wayside.

Today, additive or heavy duty oils are well accepted and used wherever the need for them is indicated. These oils are backed by the reputations of the oil companies producing them. In addition, some additives are produced and sold as such to be blended with straight mineral oils as required and the best proof of the effectiveness of some of these products is that they have withstood the test of a considerable period of time.

Since we are discussing additives as distinguished from oils containing additives, let's take one of these and see what can be accomplished through its use. Lubal is a good example and its period of usage for over 25 years speaks well for its effectiveness. Before starting, it should be pointed out that additives can be applied to both the fuel oil and to the lube oil. The purpose and functions are somewhat different.

Fuel Oil Additives

Additives can be blended in the fuel oil for a number of reasons. One of these is to improve the ignitionability of the fuel by the use of "cetane improvers". Another, is the addition of compounds to improve the burning characteristics, perhaps by the generation of additional oxygen. The effectiveness of these compounds is controversial and has not been clearly determined.



Cooper-Bessemer engine that delivered nine continuous years of operation using Lubal and the rings shown on the following page.

The purpose of additives such as Lubal "D", however, is entirely different and its effectiveness has been proven. It is largely composed of petroleum products and by-products

and is intended to keep the entire fuel system as well as some of the engine components clean and well lubricated.

It must be remembered that fuels are not always stable when stored and when subjected to temperature fluctuations both daily and seasonally, gums and sludges may form. Condensates may also collect in the tanks and contribute to sludging. These products create deposits in the piping and day tanks as well as imposing an additional load on the filters. The solvent action of this additive will materially aid in preventing these formations and thus keep the system clean. This detergent action extends into the entire injection system.

Other components of the compound have the effect of increasing the "wetability" of the fuel. This quality improves lubrication in the fuel pumps and elements of the fuel injection system. The additional lubrication provided by the additive is important when using certain types of "dry" fuels.

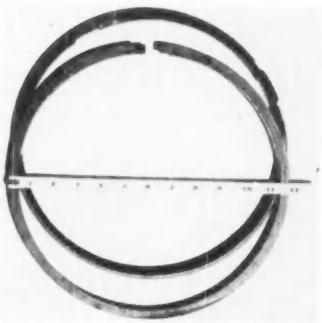
By introducing the additive with the fuel, the latter acts as a carrier to bring the compound in contact with some of the engine components. The maker states that the slow burning of the oil molecules added to the fuel allows them to contact the top ring and to aid slightly in its lubrication. Its chief action, however, is to loosen carbon deposits, permitting them to be carried out with the exhaust. It is further stated that, while no effect on temperatures is noted in normally operating diesels, they will be reduced somewhat in the case of an overloaded unit running with high temperatures.

Earlier mention was made of the operator of the large, slow speed diesel who did not seem to need any additives. Possibly he overlooked the cost and time of steaming out the fuel piping the last time that it showed heavy deposits. And how about those frequent filter replacements? These maintenance costs will buy a lot of additives, particularly when only one gallon is used to treat 500 gallons of fuel.

Lube Oil Additives

Additives for lube oils take any number of forms. To mention a few there are detergents, dispersive agents, anti-foaming compounds and oxidation inhibitors. The type of engine and service requirements determines the particular qualities necessary to maintain maximum cleanliness and general lubrication efficiency.

Before the days of heavy duty oils, Lubal "K" was developed to improve the performance of lubricating oils. Used in small quantities (1 gal. per 30 gal. of lube oil) in straight mineral oils, it does not materially alter the specifications of the original oil. Its prime function is as a detergent and by preventing the formation of varnish, gums and sludge, it keeps the engine free and clean. It might also be mentioned that some operators find it beneficial to add Lubal "K" to heavy duty oils.



Remarkably clean piston rings after nine years' operation using Lubal.

There is no question that the detergency of the lube oil with its additives is a major factor in prolonging the period of operation between overhauls. Under severe conditions, engines will gum and carbon up in a comparatively few number of operating hours. The solvent action prevents this formation of the injurious varnish, gums and sludges and carries the harmful components in colloidal suspension until removed by filtration or until the oil is changed. General engine performance will be better since all the parts are clean and free to do their job.

The ring belt area is one of the first spots to suffer from an accumulation of deposits. Stuck and gummed rings permit blow-by, aggravating the condition, and stuck or clogged oil rings lead to increased oil consumption. The latter is perhaps the first indication to the operator of the condition. There are numerous well documented cases to prove that when Lubal "K" was added to the lubricating oil, the consumption was reduced to normal, indicating that the deposits had been dissolved and that the rings could function normally again.

Other qualities of this particular additive are apparently equally beneficial. When thoroughly mixed, it is permanently miscible with any lubricating oil and gives indications of increasing the oiliness and film strength. For this reason the treated lubricants form boundry and hydro-dynamic oil films of good stability and with good resistance to extremes of pressure and temperature. An example of the latter is contained in the results of an accelerated corrosion test. In the Underwood test with one part of Lubal "K" added to 55 parts of a mid-continent lubricating oil, after 20 hr. at 325 deg.F, the loss in grams of cadmium-silver bearings was found to be less than 0.001 while a gain of 0.0033 was found in copper lead bearings.

General

Perhaps it is now possible to lay a little groundwork as a basis for settling the perennial argument concerning additives. There is no more reason to believe that straight mineral oils are the best possible lubricants, or that fuels as refined are the last word, than there is to think that everything has been discovered and progress has stopped. While it is true that these products will do an excellent job under many conditions of operation, the trend to higher pressures and temperatures as well as rotative speeds found in modern engines exacts its toll, particularly on the lubricating oil. Modern chemistry has kept step with these developments to solve the problems encountered. Additives are the answer and are a valuable tool to be used when conditions require.

One of the frequently heard arguments against their use is the matter of cost. The only realistic approach to this question is to evaluate the cost in comparison to the savings through increased engine efficiency and reductions in maintenance. It stands to reason that cleaner, better lubricated engines will last longer.

Diesels for a Coal Town

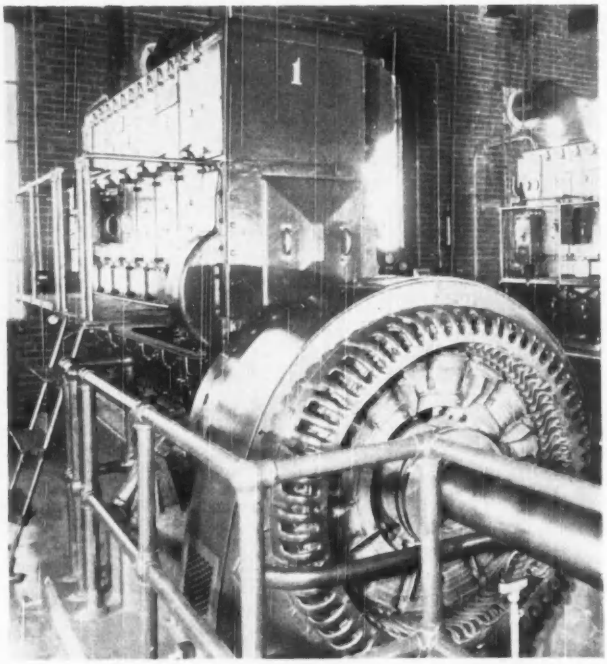
Freeburg, Ill., Solves Multiple Problems With Two 690-Hp. Superior Dual-Fuel Diesel Engines, Saves $20,000 A Year on Fuel Bill Alone.

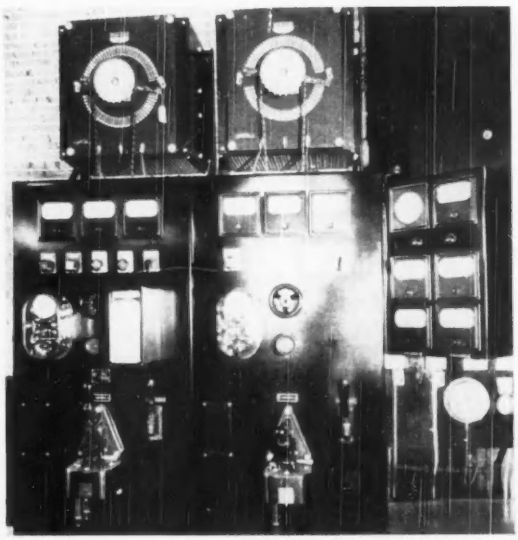
A TWO-ENGINE diesel plant is teaching the people of Freeburg, Ill., new concepts of power production economy, with savings of nearly $20,000.00 a year in the fuel bill alone. The anticipated advent of natural gas will increase fuel savings another $10,000.00 for these prime movers are Superior dual-fuel engines.

By experience and inclination, this community of 2000 population, 25 miles southeast of St. Louis, is a coal-burning town. Nearby coal mines provide a livelihood for a great many of the residents. Since 1903, power and light have been supplied by a succession of steam engines, the latest of which was installed in 1936. But economic realities can be a powerful force for change and growing deficits convinced the municipality that the steam plant was a liability and that a more efficient power plant had to be provided if rates were to be maintained.

A number of problems influenced the choice of engines. For one thing, the city wanted to keep capital expenditures down by using the old building to house the new equipment. Yet it was necessary to keep the steam plant operating until the diesels were ready. A two-engine plant was indicated. Also, Freeburg engineers had seen how rapidly other municipal plants outgrew small engines tailored too closely to current load conditions, and it was determined to purchase larger units with good efficiency at partial loads. Oil was the best available fuel but a supply of natural gas was expected and it was obviously wise to provide for eventual use of the more economical fuel.

The engines chosen were two identical turbocharged, dual-fuel Superior diesels having 6 cyl., 12-in. bore and 15-in. stroke, rated 690 hp. at 450 rpm. Each drives directly a 435-kw., 3-phase, 60-cycle, 2400-volt generator with 10-kw. V-belted exciter. The engines now run on oil but when the gas line reaches the plant it will be necessary only to push a button to





View of one of the two dual-fuel engine and generator sets which have effected a saving of $20,000 in the first year of operation and (right) the engine panels and swinging synchronization panel, installed with the new engines.

switch over to operation on natural gas.

The diesels were fitted into the plant without disrupting service and took over the full load in December, 1948, after which the steam plant was dismantled. The first nine full months demonstrated both the operating efficiency and the economic soundness of the new equipment. Table I shows monthly figures on kilowatt-hours generated, gallons of fuel consumed, gallons of lube consumed and kilowatt-hours per gallon of fuel. In nine months (the latest figures available at this writing) the diesels produced 1,331,760 kw. hr. while consuming 108,580 gal. of fuel; an average of 12.26 kw. hr. per gallon. The notable fact is that this efficiency level was achieved with an average load of less than 40 per cent. For example, on October 11, 1949 the load varied between a low of 110 kw. and a peak of 330 kw. Yet fuel consumption was kept down to levels considered satisfactory in many plants with far more favorable load factor.

The economic improvement achieved through installation of the diesels is strikingly clear in Table II which compares receipts and expenditures of the Freeburg electric department for the first nine months of 1949 with the corresponding period of 1948. While production was increased from 996,600 kw. hr. in 1948 to 1,331,760 kw. hr. in 1949, expenses were actually reduced by $7,501.75. With the augmented revenue and the production economy, a loss of $6,211.64 in the first three quarters of 1948 was translated into a net operating profit of $14,111.25 in the like period of 1949. It should be noted that the expenditures listed include the generating plant, the distribution system and the business office.

A comparison of fuel costs is of particular interest. For the periods considered, the cost of coal was $0.0192 per kw. hr. The cost of diesel fuel was $0.0081 per kw. hr., a saving of $0.0111 per kw. hr. Natural gas should bring the fuel cost per kw. hr. to less than $0.003. Further, the load is increasingly steadily and improved load factor will mean greater engine efficiency and greater fuel economy.

Table I

Operating Picture for 9 Months of 1949

1949	Kw. Hr. Generated	Gal. Fuel	Gal. Lube	Kw.Hr. per Gal. Fuel
Jan.	155,650	12,700	152	12.65
Feb.	139,660	11,060	136	12.62
Mar.	150,330	12,240	206	12.28
Apr.	139,920	11,555	175	12.11
May	138,070	11,450	183	12.06
June	143,430	11,760	126	12.19
July	155,800	12,680	134	12.28
Aug.	157,450	12,725	168	12.38
Sept.	151,450	12,410	157	12.21
9 Month Total	1,331,760	108,580	1,437	12.26

Table II

Receipts and Expenditures Freeburg Electric Department

	First 9 months 1949	First 9 months 1948
Receipts	$47,701.84	$35,880.70
Salaries	9,645.00	10,860.15
Addit. Labor	152.55	791.10
Fuel	10,841.63	19,169.89
Lube, Supplies, Maintenance	6,534.54	5,419.05
Meter Refunds	445.00	510.00
Sales Tax	1,207.99	1,016.49
Miscellaneous	4,763.88	3,325.66
Total Expenditures	33,590.59	41,092.34
Net Oper. Profit	14,111.25 (Profit)	6,211.64 (Loss)
	DIESEL	STEAM

Use of the old steam plant building forced some sacrifice in appearance but there have been no compromises on equipment quality. From the heavy-duty prime movers down to the smallest piece of auxiliary equipment, this plant is designed for long, efficient, trouble-free service.

Accessories

A detergent-type lubricating oil is purified continuously in a four-element cellulose cartridge filter for each engine. During engine operation, oil is drawn from the pressure side of the engine lube pump through the filter and into the sump tank. When the engine is not in service, a small motor-driven pump takes oil from the sump, puts it through the filter and back to the sump. Included in the lube oil system are two shell-and-tube oil coolers.

Diesel fuel is passed through cellulose filters also before reaching the engines. The fuel is delivered from tank trucks into a 15,000-gal. tank and then is pumped through meters and the two-element cellulose filters into two 250-gal. elevated day tanks inside the

plant. Flow to the engines from the day tanks is by gravity.

Air for the engines is drawn through two-element viscous-impingement type filters outside the building and is sent to the cylinders under pressure by the exhaust-driven turbocharger. Exhaust gases then vent through vertical silencers outside.

Principal elements in the closed cooling system are two evaporative coolers and two motor-driven centrifugal circulating pumps. Thermostatically-controlled shutters on the coolers keep jacket water at specified temperature. Normally one cooler and one pump are used for each engine but the piping permits alternate or combined use of pumps and coolers. City water is treated in a softener before it is used for makeup.

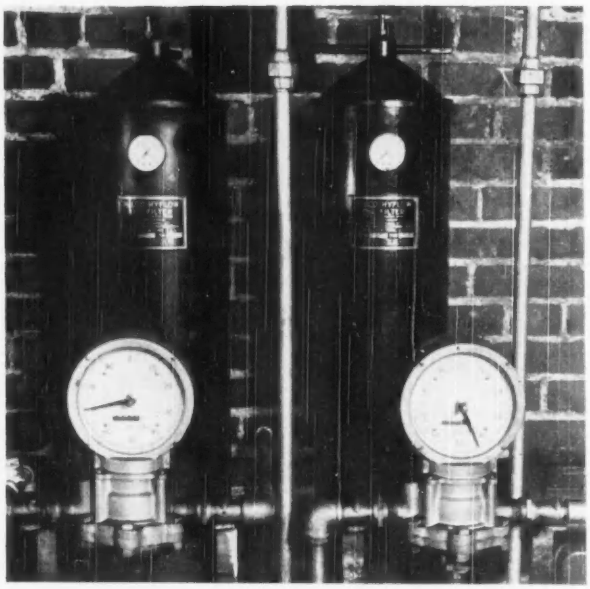
Beside each engine is a control panel with exhaust pyrometer and alarms on engine lube pressure, turbocharger lube pressure, jacket water temperature, and overspeed. On the engine itself are additional gauges and a tachometer.

Distribution is still handled from the old switchboard but two new engine panels and a swinging synchronizer panel were installed with the diesels. The modernization program calls for eventual replacement of the old board.

Starting air is supplied by two compressors, one driven by motor, the other by a gasoline engine. The first is controlled automatically to keep 200 to 240 psi. pressure in the air tanks.

The plant is operated under the immediate supervision of Cornelius Nold, superintendent of the Light, Water and Sewage Department. Major policy matters are determined in consultation with village president Louis M. Schwalb and the six-man Board of Trustees. The business office is managed by village clerk Robert Browning.

Normal operating procedure is to run one engine for a full week, then switch to the other for a week. The reserve engine provides complete standby protection. The engines are large enough to allow for substantial load expansion and there is room in the plant for additional units when the need arises.

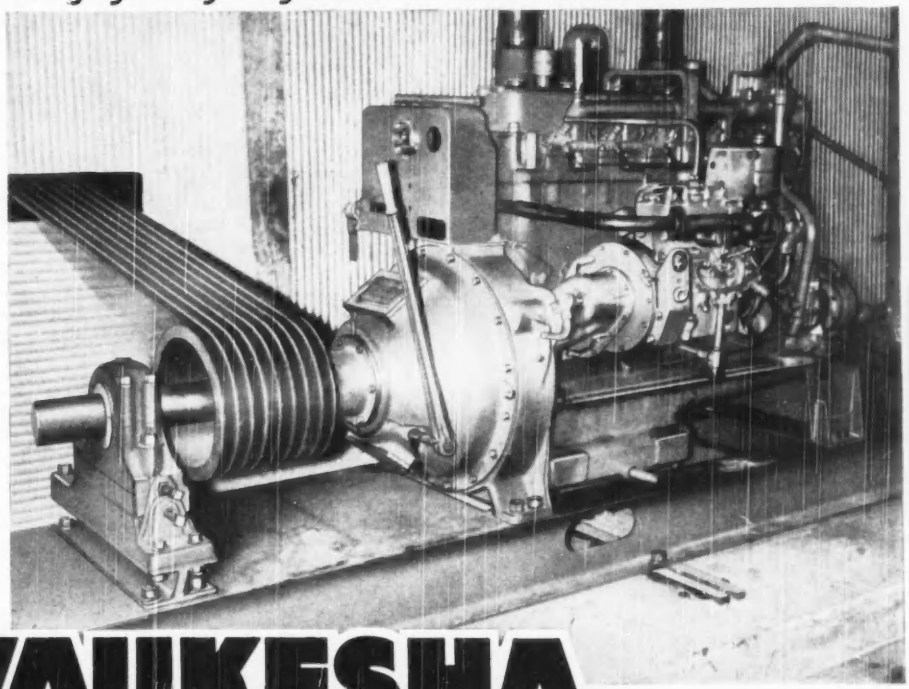


Fuel oil metering and filtering system. The fuel is delivered from tank trucks into a storage tank, then pumped through the filters to two 250-gal. day tanks.

FREEBURG, ILL., MUNICIPAL POWER PLANT
PRINCIPAL EQUIPMENT

Engines:	Two 690 hp. Model KNSD96 dual-fuel diesels. Super. Engine Div., The National Supply Co.
Generators:	Elliott Company
Turbochargers:	Elliott-Buchi
Governors:	Woodward Governor Co.
Fuel Oil:	Standard Oil Co. of Indiana
Unloading pump:	Gorman
Transfer pump:	Geo. D. Roper Co.
Fuel Meters:	Buffalo Meter Co.
Fuel Filters:	Hilco Hyflow. The Hilliard Corp.
Level Gauges:	Rochester Mfg. Co.
Lube Oil:	Nonpareil Heavy Duty Diesel Oil Heavy. Standard Oil Co. of Indiana.
Lube Filters:	Hilco Hyflow. The Hilliard Corp.
Oil Coolers:	Ross Heater & Mfg. Co.
Evaporative Coolers:	Marlo
Thermostatic Controls:	H. S. Products Corp.
Water Pumps:	Ingersoll-Rand Co.
Water Softener:	Elgin
Air Filters:	Air-Maze Corp.
Exhaust Silencers:	Maxim Silencer Co.
Air Compressors:	Quincy Compressor Co.
Control Panels:	The National Supply Co.
Exhaust Pyrometer:	Alnor. Illinois Testing Laboratories.
Switchboard:	Lake Shore Elec. Mfg. Co.
Voltage Regulators:	Burlington Instrument Co.

"WAUKESHA DIESEL has given us *uninterrupted power*...to make every ginning day count"—SAYS L. D. HORTON of HOLLANDALE, MISS.



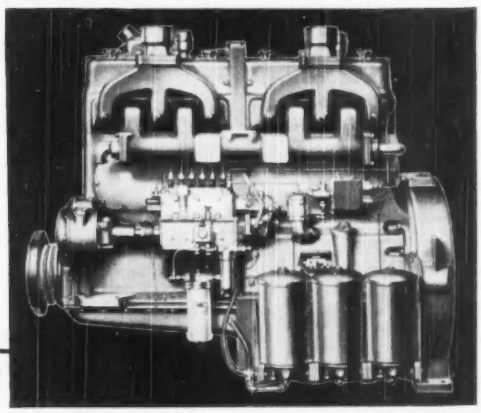
WAUKESHA ...modern GIN ENGINES

WAUKESHA 6-WAKD Diesel COTTON GIN ENGINE with gasoline engine starter—(*above*) as installed at gin of L. D. Horton, Hollandale, Miss.; (*below*) manifold side view. Maximum output, 201 hp. at 1300 rpm, with overload capacity up to 225 hp. at 1600 rpm. Bore is 6¼-in., stroke 6½-in., displacement 1197 cu. in.

Mr. L. D. Horton of Hollandale, Miss., is an experienced ginner. Here's what he says—

"When it was necessary to replace power in our gin, I decided to stick to a Diesel engine and install your Model 6-WAKD Waukesha Cotton Gin Unit. This Waukesha Diesel has given us a steady flow of uninterrupted power which every ginner should have, especially if the crop is short and you have to make every ginning day count. The engine is easy starting, simple and economical to operate. I have always felt that any machinery that operates as well as this engine should receive due credit and praise."

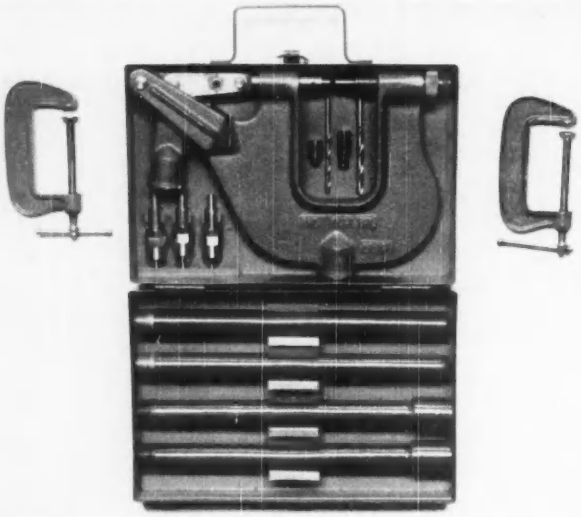
With its exclusive-patented, controlled turbulence combustion chamber, Waukesha 6-WAKD gives you unusual Diesel performance . . . complete *and* clean burning with all standard "high speed Diesel fuels" . . . lively acceleration . . . and high economy. Send for Bulletins 1434 and 1535.



WAUKESHA MOTOR COMPANY • WAUKESHA, WISCONSIN

NEW YORK TULSA LOS ANGELES

New Products



Portable Riveter

A portable industrial riveter and kit has recently been introduced by the Wadell Equipment Company. Designed for rapid riveting on shovel, crane, dragline and tractor bands up to 10 inches wide, it is said to be easily adjustable for any length rivet up to 2 inches.

The kit contains such items as a hand riveter, drills, counterbores and clamps. An adapter for riveting the facing to the cone clutch on LeTourneau equipment is also available. Counterbores are made to fit any standard $\frac{1}{4}$ in. drill and feature a gauge for setting the depth of countersink, opening for chip elimination, and are equipped with pilot pins. Counterbores can be purchased separately.

The firm says that the use of the portable riveter will enable a contractor to rivet bands in a minimum of time and thus save considerable "down time" with his equipment. This is an important consideration when working on a job containing a bonus clause for speedy job completion.

Expansion Joints

Engineering and operating personnel dealing with high pressure piping in industry's power and process fields will be interested in the "*Flexoniflex*" line of Expansion Joints announced by the Chicago Metal Hose Corporation. These units for the 1000 psi. working pressure range have been used successfully in critical confidential projects during the last several years. They are now available for use wherever gases or fluids must be conveyed under high pressures and between relatively moveable parts.

CMH *Flexoniflex* joints consist of corrugated, bellows-type, sections of stainless steel or other alloys formed within integral control rings and end sections. Unlike the control rings normally used on controlled-flexing expansion joints, the rings of *Flexoniflex* units are not bolted in place but have intimate relationship with the pressure carrier. This refinement of construction plus the design of the convolution wave and other highly engineered and carefully controlled manufacturing processes qualifies the units to withstand extremely high pressures. Research and development of this product was made in recognition of today's trend toward ever increasing pressures and temperatures in industrial power and processing activity.

Two-Headed Hammer

The Mondie Bar *M* All Purpose Mechanic's Hammer is two hammers on a single handle — one head of drop forged steel and the other of rubber — which may be particularly valuable in light or heavy work where surfaces of material must not be dented or damaged. The medium-hard, Duro Rubber Head, pressure-locked on a drop forged steel base, has a calculated low blow-recoil factor, and can do heavy work without denting or peining the material being struck. The metal head is of tough, drop forged steel. Bar *M* Hammers are available at present in the 40 oz. size only. The manufacturer is the Mondie Forge Company.

New Rotary Meter

An entirely new 350 gpm. rotary meter, known as "*Rotorol*", said to be light in weight and compact in size, for tank truck, bulk plant, pipe line, industrial, marine, high-speed fueling and other liquid measuring jobs has been announced by Bowser, Inc. Complete dynamic balancing of the rotor assembly is said to preserve accuracy and lengthen meter life by eliminating hydraulic and mechanical stresses.

Stainless steel ball bearings and needle-type roller bearings on the rotor shaft and cam rollers are claimed to provide running action so free as to offer practically no resistance to liquid flow on gravity or pump installations. Interior rotating parts are aluminum die cast, anodized aluminum and cadmium plated steel to resist rust and corrosion.

Positive displacement measurement is accomplished in a precision chamber during each quarter revolution of the rotor. A simple gear change permits flow through the meter in either direction.

Water Deionizer

A new portable low-cost deionizing apparatus is said to provide ideal water — free from harmful metallic content — for the industrial user of storage batteries.

The new product, called the *Deeminizer*, delivers water of virtually total chemical purity, which is essential to maximum battery life, in quantities up to five gallons per hour. Fed with ordinary tap water, it can yield a product with an electrical resistance of up to 10 million ohms per centimeter. Expressed another way, this means that the water will contain only one part of ionic solids per 100 million parts of water.

Manufactured by Crystal Research Laboratories, Inc., the *Deeminizer* is a miniature ion exchange tower, weighing only 5½ pounds, which involves the first commercial application of an important discovery by researchers at the Resinous Products Division of Rohm & Haas Company, Philadelphia chemicals manufacturer. Their new technique of conditioning water by passing it through a mixed bed of Amberlite ion exchange resins has been applied in the new apparatus and is the key to the result obtained.

Pocket Measuring Instrument

The *Pocket Comparator* is a high-precision optical measuring instrument for the inspection of small parts or small dimensions on large parts. The instrument was developed and is manufactured by Bell and Howell Company and is distributed by National Tool Company.

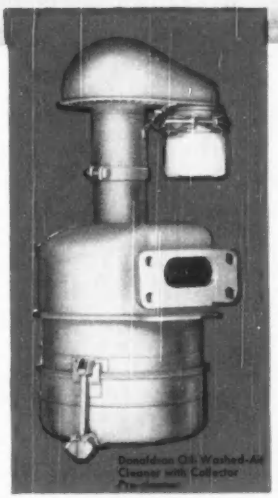
The reticle of the Pocket Comparator is calibrated for measuring lengths, widths, complete circles, radii and angles. The upper part of the reticle has lengths graduated in steps of 1/64, 1/32, 3/64, 3/32, ⅛, 3/16 and ¼ in. There is also a linear rule of ½ in. with 0.005 in. increments, and a 10 mm. linear rule with 0.2 mm. increments. Circles are shown graduated from 0.002 to 0.050 in. diameter and from 1/64 to 1/16 in. diameter. The lower half of the reticle is patterned to measure angles between 0 and 90 degrees in steps of 5 degrees, and to measure radii from 1/16 to ⅜ in.

Oil-Tite Control Stations

A new line of Oil-Tite control stations and units is available from the Westinghouse Electric Corporation. Especially designed for machine tool control and other heavy-duty installations, the Oil-Tite units can be used in any desired combination in the stations. A durable resilient gasket provides a never-failing seal against oil, coolant, cutting compound, and water.

Units and nameplates can be rotated 90, 180, or 270 deg. to enable mounting in any position. Terminals on the contact block are reversible for front and rear connection.

For surface mounting, the stations are available in die-cast enclosures with Bonderized baked enamel finish. Contact blocks can be mounted in the base, eliminating flexible leads from box to cover. When it is desired to mount the units in machine cavities, or in banks in large control stations, the contact blocks can be cover-mounted.



Under dust conditions like those in which this crawler tractor is working, any leak in the air cleaner would let in enough dust to ruin the engine.

But that big, powerful Diesel engine is protected by a Donaldson Oil-Washed-Air Cleaner and all Donaldson Cleaners are 100% sealed, with each seam and joint air tight. As a final positive check against leaks, each model cleaner is pressure tested under water. In a Donaldson cleaner, *sealing is unlimited*, leaks are completely excluded. Air can be taken into the air cleaner only through the turbulent, double-scrubbing, oil-impinging action in the air cleaner, where better than 99.44/100% of all dust is removed.

A dust concentration like that shown above, is only one of the unusual conditions that Donaldson Air Cleaners will handle. If you want assurance that your engine will be fully protected at all times, write our engineering department.

DONALDSON CO., INC.
666 PELHAM BLVD. • ST. PAUL 4, MINN.
DONALDSON CO. (Canada) LTD.
Chatham, Ontario

DONALDSON *Oil-Washed* **AIR CLEANERS**

WORLD'S LARGEST MAKERS OF HEAVY-DUTY AIR CLEANERS

JOHNSON BRONZE

Service

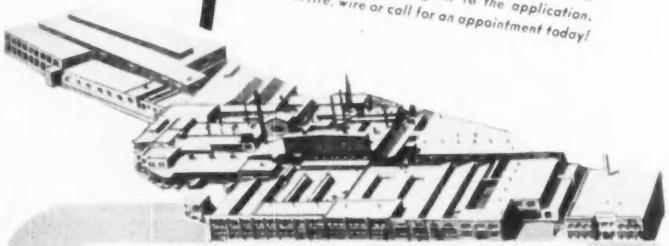
ASSURES DELIVERIES ON TIME

Large plant facilities at Johnson Bronze are operated on time schedules which give you the bearings you need when you want them. Every step in the production of diesel bearings is fitted into this concept of Johnson Bearing service.

Valuable information, written by Johnson engineers, on bearing design, types, alloys, tolerances, lubrication, etc., is available printed in 8½" x 11" data sheets. They are free . . . Write today for a set.

• *You will find Johnson engineers willing to help you decide which type bearing is best suited and to design it to the application. Write, wire or call for an appointment today!*

This modern plant of the Johnson Bronze Company, occupying over 400,000 square feet of manufacturing space, is devoted exclusively to Sleeve Type Bearings.



Johnson Bronze

SLEEVE BEARING HEADQUARTERS

470 SOUTH MILL STREET • NEW CASTLE, PA.

New Dial Bore Gauge

Utilizing a design similar to that employed in the construction of their inside micrometers, the Rimat Machine Tool Company has developed and is producing an entirely new dial bore gauge. The new tool is said to give quickly and accurately, the diameters of internal grooves for "O" rings, snap rings, oil rings, etc., as well as diameters of straight bores. The instrument locates readily on the diameter of the cut to be measured and its

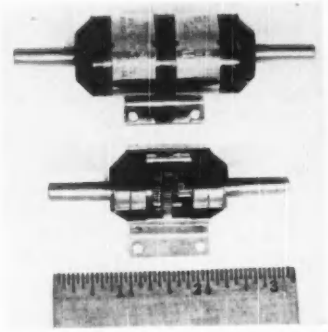
indicator dial immediately gives the desired dimension. Operator skill required in its use is a minimum and deep holes are measured as readily as shallow ones. Standard instruments are manufactured to measure all diameters from ½ in. to 6 in. Special models are produced to meet unusual customer requirements.

New Molybdenum Lubricant

Molybdenum lubrication has been made available in a form suitable for use in any conventional lubricating system, by a new development of the Lubricants Division of The Lockrey Company, which is now placing on the market a new molbydenum-base lubricant called "*Liqui-Moly*". This can be used alone, or added directly to crank-case or other oils which carry it to the friction-surfaces, where it "plates out" on the metal, providing a permanent low-friction anti-seizing coating. The firm says that actual tests have shown that friction-surfaces running at high speed and under heavy pressure will heat up from 300 to 504 per cent faster with ordinary lubricating oil than when running dry with only "Liqui-Moly", and moreover that the temperature-rise with oil is continuous until failure and seizure, whereas with "Liqui-Moly" it reaches a stabilization-point and then usually recedes.

Miniature Speed Changers

Precision hobbed gears of 96 pitch are now available in the *Metron* line of miniature speed changers. These high quality hardened gears, according to the manufacturer, provide smoother, quieter operation, better angular precision, and about $\frac{1}{2}$ the backlash that is obtainable with the 48 pitch extruded gears used in the standard units. Available in single or multiple sections and with more than 500 different ratios, these tiny units

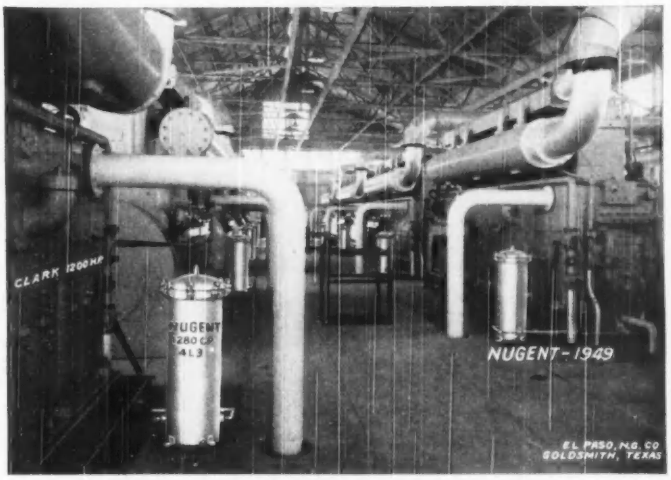


are said to be ideal for instruments, controls, computors, recorders, regulators, etc. where low-power quality gearing is required. Tentatively rated at 1/50th hp., speeds as high as 20,000 rpm. on the high speed shaft, and torques as high as $1\frac{1}{2}$ pound-inches on the low speed shaft are practical.

Relief Valve

Hydraulic Equipment Company announces a new adjustable differential type relief valve, to be known as the VR Series. This valve is designed expressly for use in high-pressure, oil-hydraulic control systems. Inherent design characteristics of the valve have entirely eliminated objectionable valve chatter. An important feature of this new VR Series Valve is the differential piston which reduces the effective area of the main poppet valve without reducing actual flow area. This new design feature allows use of lighter springs, resulting in more accurate control and longer spring life. VR Series Relief Valves are available in capacities from 5 gpm. to 30 gpm. and in pressure operating ranges between 400 psi. and 1650 psi.

Clean oil means longer compressor life



with NUGENT ABSORBENT OIL FILTERS

Nugent Absorbent Oil Filters get more out of the harmful impurities that get into oil—99.8% by actual test and cleaner oil means that engines, compressors and all machinery will last longer and require less maintenance, while at the same time require less frequent replacement of oil.

Fig. 1280CP, the Nugent Filter type shown above installed on engine-compressor units at the Goldsmith, Texas, station of the El Paso Natural Gas Company, is typical of Nugent depth type pressure liquid filters. The filtering material generally used is a superior quality of cotton waste, wool, excelsior, asbestos or cellulose. No chemicals, bleaches or filtering earths are used. All units have very large capacity for their size. Fig. 1280CP is available in a wide range of capacities. Write for complete information.

Other Nugent filters are available to meet virtually every need.

Wm. W. Nugent & Co., Inc.
417 N. Hermitage Ave. CHICAGO 22, ILLINOIS

OIL FILTERS, OILING AND FILTERING SYSTEMS, TELESCOPIC OILERS, OILING DEVICES, SIGHT FEED VALVES, FLOW INDICATORS

Established 1897

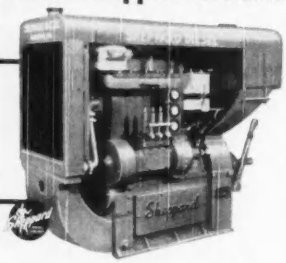
Representatives in Boston • Cincinnati • Detroit • Houston • La Junta, Colo. • Los Angeles Minneapolis • New Orleans • New York • Philadelphia • Portland, Ore. • San Francisco Seattle • St. Louis • Tulsa • Representatives in Canada: Montreal • Toronto • Vancouver

YOU HAVEN'T HEARD
"THE half OF IT"
. . . until you hear about Sheppard Diesels

Sheppard Diesels consume HALF as much fuel per hour as gasoline engines

Sheppard Diesels run on any one of 15 fuels, most of which cost less than HALF the price of gasoline

Sheppard Diesels operate 3 to 5 times longer between overhauls —cut down-time by a lot more than HALF



45 H.P. 3 Cylinder Power Unit with power take-off and clutch. Also available as 2 to 36 K.W Generating Set

Get the WHOLE story of Sheppard Diesel economy, dependability and long life. Write today for 16-PAGE BOOKLET

Diesel's the Power
Sheppards'
THE DIESEL
STATIONARY • AUTOMOTIVE

SHEPPARD DIESELS, HANOVER 7, PA.

Specify VIKING For Your Future PUMP PLANS

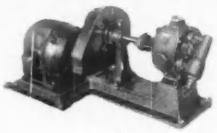


FIG. 12

Check today on your pumping equipment needs. Viking offers the most complete line in the rotary pump field. The range of sizes and styles are the largest available.

Each is built to handle the specific job. Outstanding features include fast self priming . . . smooth, even discharge . . . low power requirements . . . compact and rugged construction.

VIKING AN HONORED NAME IN PUMPING

Send today for free bulletin 2201D.

See Our Catalog in SWEET'S

Viking PUMP COMPANY
Cedar Falls, Iowa

Flex-Head Wrenches

Snap-on Tools Corporation now has available three new *Flex-Head* wrenches. The construction of these wrenches is said to provide the safety and power of the socket wrench plus greater clearance advantages when working under obstructions.

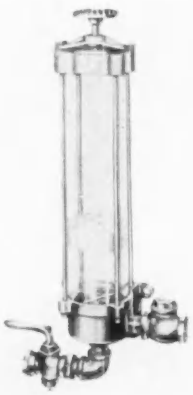
The double-hexagon, broached heads flex over 180 deg. to give all angles of turning action. With the handle in a vertical position the nut can be spun on and the handle then flexed over for the final tightening, an important feature for fast nut turning. With the handle in a horizontal position little overhead clearance is necessary, making them ideal for work beneath cross members or other obstructions.

These wrenches have different size openings at each end for greater adaptability and are available in the following sizes: $\frac{3}{8}$ and 7/16 in., $\frac{1}{2}$ and 9/16 in., and $\frac{5}{8}$ and $\frac{3}{4}$ in. Overall lengths range from $5\frac{5}{8}$ in. for the smallest to $8\frac{3}{4}$ in. for the largest, and all of them are chrome plated.

Hydroblender

An automatic, self-draining *Hydroblender* for the introduction of chemicals that will "wet" water at the point of use, has just been announced by the Aquadyne Corporation.

The *Hydroblender*, made of brass castings and fittings and a tube of lucite, weighs approximately 35 pounds. It can be mounted on wall, machine or column by four lag bolts or screws.



The chemicals are placed in the lucite tube in the form of water-soluble capsules. There they dissolve in proper proportion to the water passing through a built-in venturi nozzle. When used with Aquadyne capsule which weighs 3 pounds the resulting solution has a surface tension of 30 dynes. Each Aquadyne capsule makes a minimum of 1000 gallons of "wet water" (reduces surface tension from 72 to 30 dynes). The Hydroblender holds two capsules.

Contour Following System

An instrument that can follow the lines of a drawing and guide a machine tool to cut out metal parts accordingly was described at the winter general meeting of the AIEE, held in New York.

T. M. Berry, General Electric engineer, said that the instrument, called a contour following system, "looks" at an outline drawing with an electric

eye, follows the lines, and controls a machine tool so that it turns out metal parts in accordance with the drawing.

It was designed by G-E engineers to simplify and speed up the manufacture of irregularly-shaped metal parts, often difficult to make by hand-controlled machining methods. Mr. Berry told the meeting. "With this system, production of any shape can begin as soon as an accurate outline drawing has been made," he said.

Flexible Metal Conduit

Chicago Metal Hose Corporation announces an added type Geon covered flexible metal Machine Tool Conduit to its extensive line.

According to the announcement this Geon covered conduit may be used for electrical shielding purposes in many applications and is particularly suited for use on machine tools because of its resistance to moisture, coolants, greases and oils. The tough, abrasion-resistant cover is applied over a highly flexible galvanized steel convoluted steel tubing. This durable steel core and tough Geon cover provide a conduit to withstand abuse of installation and the wear of long usage.

Non-Lubricated Valve

A non-lubricated cylindrical plug industrial control valve, providing leak-proof shut-off while eliminating contamination, has been developed by Minneapolis - Honeywell Regulator Company.

"The new valve provides leak-proof service without the use of a lubricant, which was needed in previously designed control valves," said Ernest W. Horvick, industrial engineer of Honeywell's Belfield Valve division.

The new design includes a permanent seal at the plug stem, sealing packing at the base of the plug, and a fixed-load spring, combined with a closer dimensional tolerance and micro-finish on the plug and body bore, Horvick said.

Torque tests show that the cylindrical valve's greatest torque requirement, about 250 inch-pounds at a line pressure of 250 psi., was equivalent to a force of only 12½ pounds acting on a lever arm 20 inches long.

there's a finer
Snap-on*
SCREW DRIVER
for every job
Snap-on "Octo-Grips" are the choice of better mechanics for the simple reason, you cannot buy a better driver. The handles are of tough, shock-proof black plastic . . . they're 8-sided to prevent rolling and to give you a powerful turning grip. The fine alloy steel blades are electrically heat-treated to develop maximum strength and toughness and have precision cross ground tips.
No matter what your screw driver requirements may be, look to Snap-on for the finest money can buy! Write for catalog.
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Snap-on Tools
THE CHOICE OF BETTER MECHANICS

Fire Fighting Units

With the introduction of its large stationary fire fighting units, Ansul Chemical Company is making a bid for new markets in the rapidly expanding field of dry chemical fire protection.

These units are being built in 500 lb., 1000 lb., and 2000 lb. capacities. They are designed to protect wide areas where a minimum of manpower is available — such as gasoline bulk plants, gasoline storage areas, refineries, railroad yards, petroleum and natural gas fields, large chemical plants, liquefied petroleum gas tank farms and other major public utility hazards. One person can operate the Ansul stationary unit and fight a fire in any portion of an area several acres in size.

The stationary unit itself consists of a centrally located steel tank containing dry chemical and nitrogen cylinders (used to pressurize the tank). Piping runs underground from the tank to one or more hose houses where one inch chemical engine hose is coiled. Hose may be obtained in 50, 100 and 150 foot lengths.

Bronze Bars

National Bearing Division of American Brake Shoe Company announces an expanded line of cored and solid "Tiger" Bronze bars in all popular sizes, both rough and machined. Complete stocks are now available for immediate delivery from plants in Meadville, Pennsylvania; St. Louis, Missouri, and Chicago, Illinois.

A six-page bulletin, listing size and weights of these bars, shows the physical properties of "Tiger" Bronze and describes the many uses and advantages of this exceptionally wear and shock resistant, anti-frictional material.

Heat Exchanger Line

Expanding its redesigned line of Heat Exchangers available from stock, Young Radiator Company announces its new Type "R" (removable tube bundle) Shell and Tube Heat Exchangers.

Standardization is said to offer exceptional savings in both time and money by quicker delivery, and low original and maintenance costs.

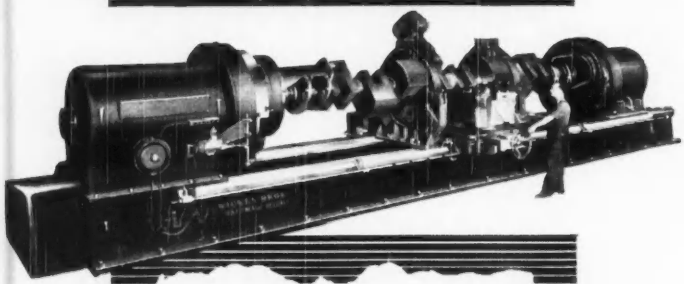
New Chemical Feeder

A new chemical feeder that is said to operate continuously with no extra attention in wet or dry oil fields has been announced by Manzel, Inc.

The new chemical feeder has a built-in force feed lubrication system, that assures complete lubrication of the waste gas-driven motors, preventing the corrosion that frequently causes stoppage and results in bad tanks of oil. It eliminates excessive manual labor formerly necessary in order to keep feeders constantly operating in wet gas fields.

The new Manzel Feeder is available with reciprocating or rotary drive gas motor, operating on as low as 3 lbs. pressure. It supplies any desired amount of chemical from $\frac{1}{2}$ pint per hour up. Also available is a kit for conversion of present chemical feeders to force feed lubrication.

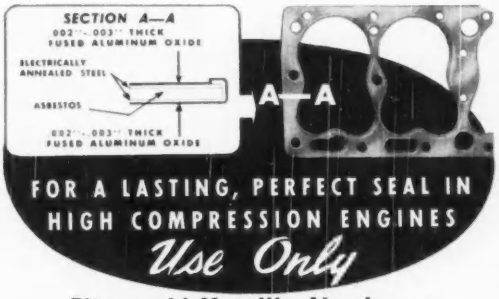
SAVE UP TO 400%
MACHINING TIME WITH
WICKES
UNIVERSAL CRANKSHAFT
LATHES



Higher production and greater flexibility accompany the Wickes Universal Crankshaft Lathe, designed to machine crankpins and line bearings on all sizes and types of crankshafts. Savings in time up to 400% have been made by machining in this lathe as compared to the time of machining in an engine lathe. Wickes Universal Crankshaft Lathes are equipped with single or double end drive, indexing and stroke setting pot chucks, 3-station turret and a back roller rest. If you have a crankshaft turning problem, call on us for time studies and proposals on the most suitable equipment.

WICKES BROTHERS
SAGINAW, MICHIGAN
Established in 1854
DIVISION OF THE WICKES CORPORATION

Complete Line of Crankshaft Turning Equipment • Thread Milling Machines • Heavy Duty Engine Lathes • Special Production Lathes • Sheet Reclaiming Rolls



FOR A LASTING, PERFECT SEAL IN HIGH COMPRESSION ENGINES

Use Only

Fitzgerald Metallic Aluminum-Fused-Oxide Steel Asbestos Gaskets*

Grease Retainers — Cork Gaskets

FITZ-Rite* Treated Fiber Gaskets for oil, gasoline and water connections. Complete Sets For Motor Rebuilders. *S. M. Reg. Pending

FITZGERALD *Gaskets*

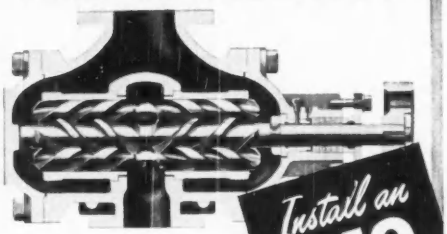
SINCE 1906

The Fitzgerald Manufacturing Company

TORRINGTON, CONNECTICUT

There's a Fitzgerald Gasket for every Engine

NEED RELIABILITY?



Install an **IMO**

● In an IMO pump there is practically nothing to get out of order or to adjust. The IMO has only three moving parts — a power rotor and two idler rotors. It has no reciprocating members, no valves, no synchronized mechanisms, no pilot gears and no sliding vanes.

IMO pumps can be furnished for practically any capacity and pressure required for oil, hydraulic-control fluids and other liquids.

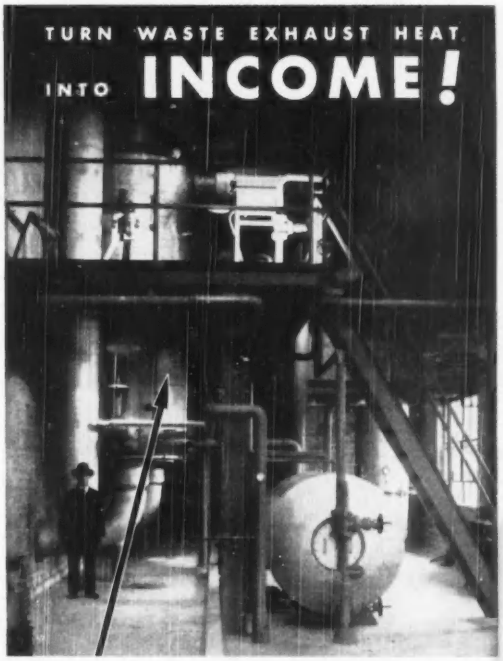
Send for Bulletin I-143-DP

IMO I MOVE OIL

IMO PUMP DIVISION of the DE LAVAL STEAM TURBINE CO.

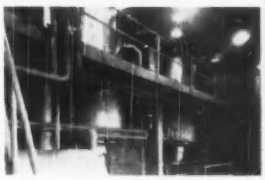
TRENTON 2, NEW JERSEY

TURN WASTE EXHAUST HEAT INTO **INCOME!**



MAXIM HEAT RECOVERY SILENCERS

produce steam for plant heating and for sale to nearby customers



Close-up view showing two BVS Heat Recovery Silencers at New Prague: accumulator tank in left foreground.

The municipal power plant at New Prague, Minnesota makes good use of Maxim Heat Recovery Silencers. Waste exhaust heat that would normally go up the flue is used as it passes through the heat recovery silencers to produce usable and salable steam. The steam in this case is used for heating the plant itself, and surplus is sold for heating nearby homes, stores, and a factory.

Thus the New Prague municipal plant achieves effective and very necessary silencing of exhaust noise, but makes this silencing pay for itself many times over.

More and more industrial users, long accustomed to the necessity of effective silencing, are now realizing the profit possibilities of installing heat recovery silencers to produce steam for heating or processing operations, and without any extra fuel cost.

THE MAXIM SILENCER COMPANY

93 HOMESTEAD AVE. HARTFORD 1, CONNECTICUT

Please send bulletin on silencers for,

DR. SHUSH

☐ Heat Recovery ☐ Intake

☐ Exhaust ☐ Spark Arrestors

Name

Company

Address

BE SURE IT'S A

MAXIM

Field Notes

Spread Features New Wrinkles

Novel tools were used to cut time and costs when Evans & James of Little Rock, Ark., laid a 382-mile Refugio to Crane, Texas, 10-inch line for Atlantic Pipeline Company, a job begun last spring and finished in the fall. One innovation, shown in this trailers-eye view over the dope wagon, was cleaning and doping in a singl operation. The cleaning unit, powered by an International U-4 engine, spread the dope on cleaned pipe by pulling a burlap sleeve as it moved forwar An International TD-18 crawler with Superior sideboom cradled the pipe.

License Agreement

It was announced recently by Dr. Alfred J. Buchi, Swiss engineer and inventor, and Baldwin Locomotive Works, that the litigation between them in the United States District Court in Philadelphia had been terminated by agreement. The case, which involved the Buchi System of diesel engine turbocharging, was brought by Baldwin and presented a dispute about patent validity and anti-trust violation. Baldwin signed a modified license agreement with Dr. Buchi covering the period in dispute and settlement was made. The court actions of both parties were discontinued.

The Buchi turbocharging system increases the power output of diesel engines by 50 per cent and more, and is in world wide use here and abroad in railroad, stationary and marine engines. Dr. Buchi is said to have further improvements which will be presented to the diesel manufacturers.

Mine Safety Division

Mine Safety Appliances Company, Pittsburgh, has established an International Division to coordinate the activities of its subsidiaries in Canada, South Africa and Great Britain, and to continue the activities of the company's present Export Department.

C. M. Donahue will be Manager of the new Division, in addition to his present duties as Manager of the Mining Djvision. H. E. Redenbaugh will be Assistant Manager of the International Division.

Mannheim Diesel

The MWM Mannheim diesel, better known in this country as the MWM Benz, is being placed on the American market again. It is offered in 1, 2 and 3 cylinder models rated 12-14, 24-28 and 36-40 hp. respectively The engines are 4-cycle types with normal operating speeds of 1500 rpm. and a short overload capacity of 10 per cent. Larger MWM diesels ranging up to 1000 hp. are being introduced at the same time. The selling agent is Ernest Frankel Associates of 22 E. 40th St., New York, N. Y.

Dravo Distributor

Dravo Corporation, Pittsburgh, Pa., has announced the appointment of Condaire, Inc., 3248 Gravois, St. Louis, as distributor of Dravo "Counterflo" Heaters in eastern Missouri and the southern half of Illinois.

R. C. Denkmann is president of Condaire and Fred Schulte will assist in the sale of Dravo heating equipment which is used for space heating, year 'round ventilating, process drying, tempering make-up air and other functions in industrial and commercial structures.

Link-Belt Expands

Link-Belt Company announces the opening of a factory branch store and warehouse in Kansas City, Mo., at 2630 Holmes St., in a two-story building with a total floor area of 13,200 sq. ft.

It is conveniently reached by bus, truck, car or taxi, being only a half mile from the Union Station and 1½ miles south of the center of the downtown business district.

Ample stocks of conveying and power transmission machinery parts, chains, sprockets, bearings, speed reducers, elevator buckets, etc., will be carried at the new address so that customers in the Kansas City area and surrounding territory can be served promptly from local stocks.

Heads Industry Fund Campaign

Burl S. Watson, President of Cities Service Oil Company, will lead the heavy industries of New York in the 1950 Red Cross Fund campaign, it was announced recently by Major General William H. Draper, Jr., New York Chapter Fund chairman.

Mr. Watson, his division chairmen and committeemen will carry the Red Cross appeal to the metals and machinery industries and to the companies engaged in the petroleum, paper and chemicals fields.

In the 1949 campaign, Mr. Watson led the petroleum industries group.

Catalytic Cracking Units

Plans for three more Thermofor Catalytic Cracking units to be constructed at refineries in Buffalo, N. Y., were announced recently by the Socony-Vacuum Oil Company, Inc.

These three are in addition to the four other units announced several months ago for Socony-Vacuum refineries at Trenton, Mich.; Augusta, Kan., and at Beaumont. Contractors have started work on several. Completion of all is scheduled during 1950. The Beaumont refinery is operated by Magnolia Petroleum Company, a Socony-Vacuum affiliate.

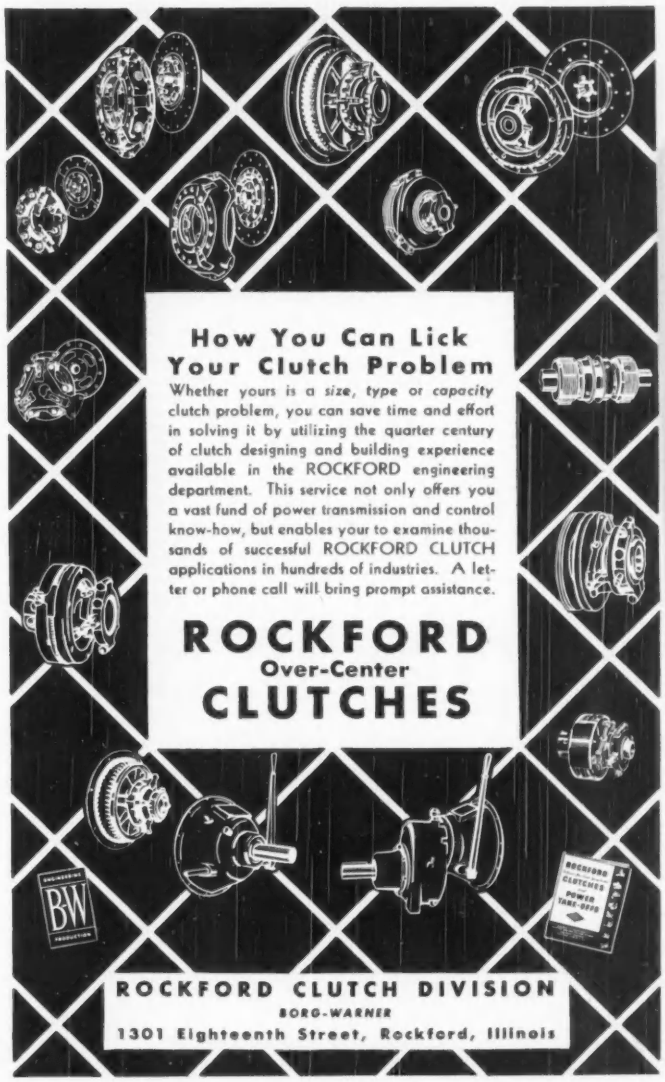
In every case, the new TCC units with moving-bed catalysts will replace existing Houdry fixed-bed units. They will provide an increase of 50 per cent over the present 10,000-barrel-per-day capacity of each Houdry unit for a total throughput of 105,000 barrels daily. Each barrel has a capacity of 42 gallons.

ASA Directors

The American Standards Association announces election of three new members of its Board of Directors effective January 1, 1950, for a term of three years. Maurice Stanley, Chairman of the Board of the Fafnir Bearing Company, represents the Anti-Friction Bearing Manufacturers Association, Inc.; B. S. Voorhees, vice-president of the New York Central System, represents the Association of American Railroads; and Colonel J. G. Vincent, vice-president, Packard Motor Car Company, represents the Automobile Manufacturers Association.

In addition, E. E. Potter, vice-president of the General Electric Company, has been named by the National Electrical Manufacturers Association to fill out the unexpired term of Clarence L. Collens, who has just retired as chairman of the Reliance Electric and Engineering Company. Miss Ardenia Chapman, Dean of the College of Home Economics, Drexel Institute of Technology, Philadelphia, is completing the unexpired term of Mrs. Carol Willis Moffett, well known for her work with the American Home Economics Association, as member-at-large.

Continuing on the Board for another three-year term are J. H. McElhinney, vice-president of the Wheeling Steel Corporation, representing the American Iron and Steel Institute, and Auguste G. Pratt, Chairman of the Board of Babcock & Wilcox Company, representing the American Society of Mechanical Engineers. R. Oakley Ken-


How You Can Lick Your Clutch Problem
Whether yours is a size, type or capacity clutch problem, you can save time and effort in solving it by utilizing the quarter century of clutch designing and building experience available in the ROCKFORD engineering department. This service not only offers you a vast fund of power transmission and control know-how, but enables your to examine thousands of successful ROCKFORD CLUTCH applications in hundreds of industries. A letter or phone call will bring prompt assistance.
ROCKFORD
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1301 Eighteenth Street, Rockford, Illinois

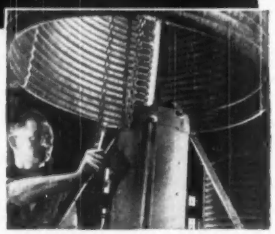
Take advantage of this

UNEQUALED EXPERIENCE

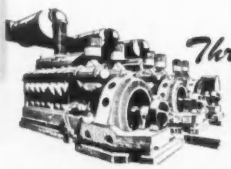
UNEQUALED PRODUCTION

When you specify Aerofin finned heat-transfer surface, you specify high efficiency, long life and easy maintenance. As pioneer in the field, Aerofin has developed unequaled know-how and production facilities to apply to your particular heat-transfer application. Attention to the many details that make up the completed unit typifies the Aerofin way.

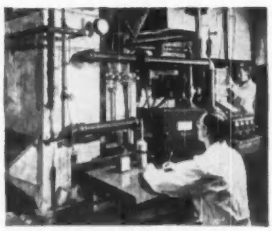
Continual research accounts for the accuracy of Aerofin's published ratings. You can use them with full confidence.



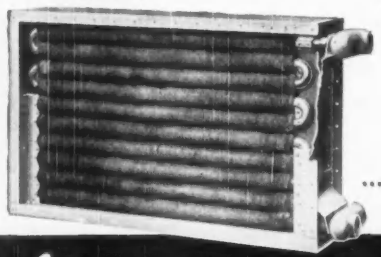
Aerofin manufactures finned heat-transfer surface exclusively. The experience gained by such specialization permits the selection of just the right surface and materials for each particular job — for each application.



Throughout the **POWER** *Industry-*



Aerofin controls every phase in the production of its finned heat-transfer coils and units. This control is maintained by rigid specifications and inspection, and all assembly is done in the Aerofin plant.



...Aerofin units do the job Better, Faster, Cheaper

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Syracuse 1, N. Y.
NEW YORK • CHICAGO • CLEVELAND • DETROIT
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nedy, formerly vice-president of Cluett, Peabody and Company, Incorporated, has been re-elected member-at-large for the next three years.

Auto-Lite Cuts Prices

Price reductions averaging better than 7.5 per cent for the entire line of Auto-Lite batteries have been announced by W. E. Blank, sales manager of Auto-Lite Battery Corporation.

"When coupled with reductions averaging 16 per cent announced last May, this means a cut of almost one-fourth in the cost of automotive storage batteries in less than a year," Mr. Blank pointed out.

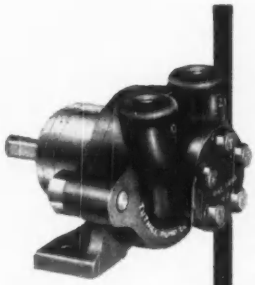
"The new prices reflect the decline in the price of lead plus the production efficiency of Auto-Lite's seven modern manufacturing plants in the United States, the newest of which was opened in Los Angeles only a few months ago," Mr. Blank said. "It has always been Auto-Lite's policy to make such savings available to the public as rapidly as possible."

Locomotive Deliveries

Deliveries have already begun on Pennsylvania Railroad orders, placed two months ago, for 226 new diesel-electric road and switching locomotives, the railroad announced recently. Twelve 1000 hp. switching locomotives have been delivered and placed in service this month.

Deliveries of road locomotives began in February, when nine freight locomotives went into service, out of the order for 45. Delivery of the five passenger road locomotives included in the order will begin in March and be completed the next month. Of the 176 switchers covered by the order, 37 more are expected in February, and 25 in March. By early summer most of the new engines will be in service.

The new locomotives, costing $38,000,000, will increase the Pennsylvania's diesel fleet to 820 locomotives, totaling 1,433,100 horsepower, making the railroad the largest operator of diesel locomotives, as well as the largest user of coal-burning and electric locomotives.



THIS SMALL PUMP CAN DO BIG THINGS FOR YOU

IN PRESSURE LUBRICATION

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FOR FUEL OR LIQUID TRANSFER

It's the Tuthill Model L . . . a positive displacement, internal-gear rotary pump with the famous Tuthill mechanical seal. Capacities up to 3 g.p.m. at pressures to 400 p.s.i. Ring or foot mounting. Many porting arrangements. Write for Model L bulletin.

TUTHILL PUMP COMPANY

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If you have a friend or associate who you think might be interested in reading DIESEL POWER & DIESEL TRANSPORTATION, and would like to send him a free sample copy, we should be glad to cooperate with you. All you need to do is to fill in the convenient coupon while you have it in hand and drop it in the mail today. There is absolutely no cost or obligation to you. PLEASE PRINT PLAINLY.

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DIESEL USERS!

Here's how FRAM FILTERS *can save you money . . .*

Read these excerpts from the letter of a Fram user . . .

Telephone 910

UNITED FISHERIES COMPANY
Distributors for Portuguese Nets
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November 15, 1948

Fram Corporation
Providence 16, R. I.

Gentlemen:

"I have installed Fram Filters on the lubricating and fuel systems of my fishing boat 'Paul Howard.' Engine is rated at 425 horsepower.

"Before using Fram, engine and parts would get caked with sludge...often causing engine trouble.

"Now, I find oil and engine unusually clean. Fram Fuel Oil Filter removes dirt and scum before it reaches injection system.

"One set of cartridges good for 1000 to 1200 hours before oil starts to darken. Fram Filters have done a job far above my expectations. Pleased to recommend them."

Very truly yours,
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By: [signature]

FRAM Can Help You!

No matter what your Diesel oil filtering problem—fuel or lube—Fram can help you conquer it. Let Fram's Research Department help you by determining what Fram Filcron Oil Filter you need for keeping injectors clean and efficient . . . keeping vital moving parts free from the damage caused by dirt, dust, grit, sludge and abrasives.

Save money, time on overhauls, breakdowns, the Fram Filcron way. Write today to Fram Corporation, Providence 16, R. I. *In Canada:* J. C. Adams Co., Ltd., Toronto, Ontario.

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STUDS • BOLTS • NUTS • ALLOYS

STAINLESS • CARBON • BRONZE

Sheppard Conversion Kit

At the recent 34th Annual Pennsylvania Farm Show, Sheppard Diesels announced the addition of a new three-cylinder, full-diesel engine to their line of diesel farm tractors and diesel engines. The new diesel, Model 6M, is actually a complete conversion kit designed and produced for the express purpose of converting Farmall "M" gasoline tractors to full diesel power.

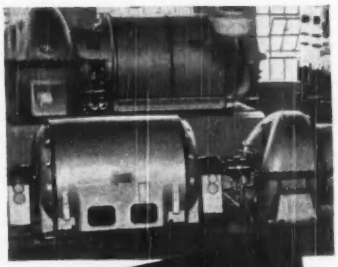
The new Sheppard 6M Conversion Kit is unique in that it is the first such unit to be engineered and produced for so sharply defined a purpose. While this unit will fit the "W6", "MV", "O6", "OS6", "16", "T6", tractors and the Model "U6" Power Unit, it was produced principally for the conversion of the Model "M" gasoline tractor to full diesel.

Of particular interest to users of this conversion kit is the fact that installation of the full diesel engine in the Farmall "M" tractor requires less than a day's time. No special tools are required for the change-over, all required parts are contained in the conversion kit. Also of importance is the fact that installation of the diesel does not alter the physical dimensions of the Farmall "M" in any way. All implements designed for use with the gasoline "M" can be used with the tractor after the change-over to full diesel power.

Merger Announcement

The merger of American Air Filter Company, Inc.,' manufacturer of air filters and dust collectors, and Herman Nelson Corporation, Moline, Ill., heating and ventilating equipment producers, became effective as of January 6, 1950, according to an announcement made by W. M. Reed, president of the American Air Filter Company, surviving corporation.

The Nelson Corporation henceforth will be operated as the Herman Nelson Division of American Air Filter Company, Inc. and will continue to maintain its headquarters and facilities in Moline. The merger company's principal offices and headquarters will be in Louisville, Ky.



Give YOUR Equipment that New Look!

IF your Diesels, generators, other heavy equipment look a little "seedy"—smarten them up with Oakite Renovator. All you do is give them a quick rub-down with this specialized paint cleaner. Then follow with a dry-cloth polish to bring out high paint-luster.

Oakite Renovator is a solvent-emulsion type cleaner. It goes after grime in a hurry. As to fire risk . . . nothing to worry about! Oakite Renovator is mixed with water . . . it's safe to use. And from a cost angle . . . Oakite Renovator is extremely economical . . . it stands dilution very well.

FREE MANUAL gives complete story on keeping equipment clean and ship-shape. Manual also describes 70 other ways to save time and money in power plant maintenance. Discusses such subjects as

- **Descaling Cooling Systems**
- **Repair parts degreasing**
- **Reconditioning filters**
- **Cleaning hard-to-reach places by Steam-Detergent Gun**

You may have a free copy of this helpful manual merely by dropping a line to address below. No obligation, of course.

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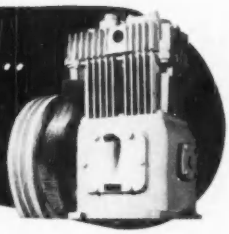
SPECIALIZED INDUSTRIAL CLEANING MATERIALS • METHODS • SERVICE



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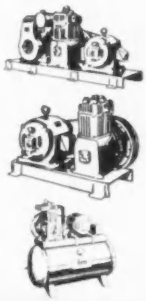
STANDARD CHOICE OF
LEADING DIESEL MANUFACTURERS

Diesel starting requirements demand dependability and durability. Quincy Compressors are standard with leading diesel manufacturers because Quincy features assure dependable performance . . . long, trouble-free service life. Quincy Compressors are available in a wide variety of sizes 1 to 90 cu. ft. displacement, up to 500 lbs. discharge pressure. Units available as illustrated. Quincy manufactures air compressors exclusively.



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TAKES LITTLE SPACE—COOLS MOBILE DIESELS *Efficiently*

"Buffalo" AXIAL FLOW FAN

- Relatively high-velocity delivery — ideal for cooling action!
- "Bee-Line" design means high efficiencies in small-space fans!
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- Widely used in the expanding Diesel market!
- WRITE FOR BULLETIN 3533-C!

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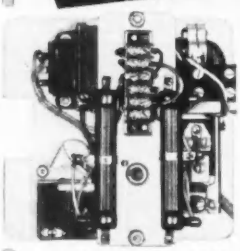
Burlington *Synchrostat*
✓ LOW COST ✓ Dependable VOLTAGE REGULATOR



Interior view of Type SR-SF

Generator Voltage Regulators For Portable Or Stationary Power Units

Burlington Regulators are available in various case styles for AC Power Units up to 25000 KW and DC up to 7500 KW.

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Look at a Diesel. The flexible metallic hose you see is very likely by ATLANTIC. Whatever the Diesel application — marine, automotive, rail or for stationary service — ATLANTIC FLEXIBLE METAL HOSE is in there doing its job.

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Made of bronze, steel or stainless steel as specified. Sizes ⅛" to 36" I.D. inclusive. Standard or special couplings, flanges, nipples and fittings.

Our DIESEL BULLETINS 1020 and 50A supply complete information.

ATLANTIC

METAL HOSE CO., INC.

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Organizational News

Hunt-Spiller Superintendent

Hunt-Spiller Manufacturing Corp., producers of diesel castings, has announced appointment of Harry Oldham as foundry superintendent. He was associated with the foundries of Ford Motor Co. for 23 years and, more recently, general foundry superintendent, Mack Manufacturing Corp.

Fairchild Research Director

Richard S. Boutelle, President of Fairchild Engine and Airplane Corporation, announced recently the appointment of Lawrence B. Richardson as Director of Research.

Formerly President of the Corporation, Mr. Richardson remained as a consultant to the new management following the proxy contest last July, which resulted in the election of a new Board of Directors.

Morse Chain Change

Robert G. Holmes has been appointed Branch Manager of the Chicago sales office of Morse Chain Co., Division of Borg-Warner Corp. Holmes' appointment was announced recently by R. J. Howison, General Sales Manager of Morse Chain Co.

Holmes has an extensive background in the industrial power transmission field. He has been a sales engineer for the last 12 years in the Chicago and St. Louis areas.

Cummins Appointments

The promotion of Earl G. Ellis to general service manager and A. C. Zugar to sales engineer have been announced from the Fort Worth headquarters of Cummins Sales & Service, Inc., by President and General Manager J. E. Everroad.

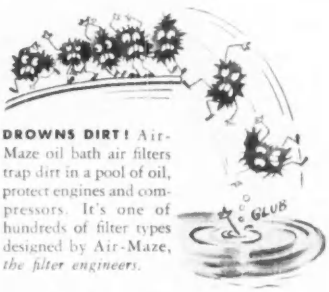
Ellis, former export service manager stationed at Caracas, Venezuela, is headquartered at Fort Worth. Zugar, formerly at the Odessa service point, is at the new and modern factory-type service shop at Oklahoma City.

Ellis has been with the company since 1941, where he started in the diesel department at Odessa and Zugar has been with the firm since 1946.

AIR-MAZING FACTS

UP IN SMOKE! Two million tons of dust and soot are discharged into New York City's air every year from furnace fires and other types of combustion.

FAZED BY HAZE? Electromaze electric air filters clear the air of dust, pollen—even smoke—by trapping particles as small as 1/250,000 of an inch. "File drawer" design makes Electromaze easier to clean, easier to fit and install.



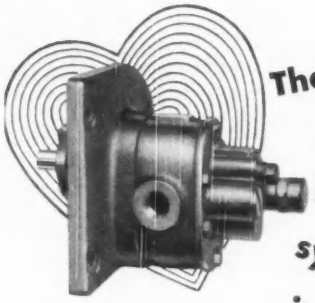
DROWNS DIRT! Air-Maze oil bath air filters trap dirt in a pool of oil, protect engines and compressors. It's one of hundreds of filter types designed by Air-Maze, *the filter engineers.*

WHETHER YOU BUILD or use engines, compressors, air conditioning and ventilating equipment, or *any device using air or liquids* —the chances are there is an Air-Maze filter *engineered* to serve you better. Representatives in all principal cities, or write Air-Maze Corporation, Cleveland 5, Ohio.

AIR-MAZE

The Filter Engineers

AIR FILTERS
SILENCERS
SPARK ARRESTERS
LIQUID FILTERS
OIL SEPARATORS
GREASE FILTERS



The HEART of a diesel lubricating system is its PUMP

Rotary geared pump with special flange mounting becomes integral part of diesel engine when installed. Note opening above relief valve for tachometer.

Modern diesel operation generally requires a pressure lubricating system — and the vital element is the pump. Thousands of Brown & Sharpe pumps are now providing reliable service month after month without interruption, for lubrication, transfer, or booster systems. Available with various types of flange mountings and special internal construction to meet specific requirements. Write for catalog. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

We urge buying through the Distributor

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Specify COLUMBIA A. C. and D. C. GENERATORS

- For Coupled Service
- For Belt Drive
- Single or Two Bearing

Columbia, with its years of experience, brings to generator set assemblers a wide line of performance proved, sturdily built, A. C. and D. C. Generators.

AC Generators: 6¼ to 1000 KVA
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Write for information. Our Engineers will be glad to review your requirements.

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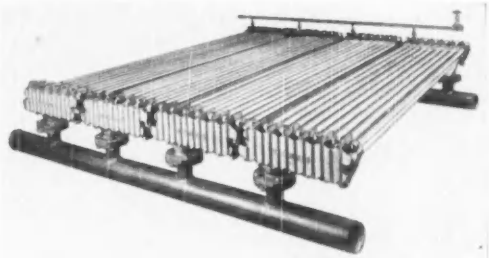
Binks Diesel cooling systems *Slash* Diesel "down time"



ABOVE: Binks Type "D" coils are strongly built with heavy 1-inch O. D. copper tubes, rolled into place in cast iron headers and flared down into a finished seat.

RIGHT: Binks cooling towers, used in conjunction with Binks heat exchange coils, simplify the maintenance of uniform jacket water temperatures and hence increase engine efficiency.

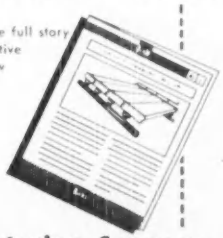
Type "D" evaporative heat exchange coils for closed-type Diesel cooling systems

- **Reduce Diesel breakdowns**
- **Eliminate scale**
- **Lower breakdown insurance rates**
- **Permit higher, controlled operating temperatures**
- **Give high cooling efficiency**
- **Permit high fluid velocity with minimum friction**

Binks Type "D" heat exchange coils bring new economies...new security to operators of Diesel engines. Now you can economically use soft or treated jacket water. Scale formation is eliminated. "Down time," caused by such engine troubles as overheating, lowered operating efficiency and breakdown, is reduced to a minimum.

Write today for your free copy of the new Bulletin 41.

This interesting bulletin tells the full story of Binks Type "D" evaporative heat exchange coils...tells how you can benefit from new economies through their use. Complete with drawings, photographs, and tables.

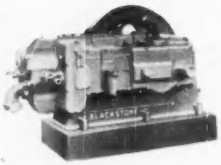


Binks Manufacturing Company
3114-38 Carroll Avenue, Chicago 12, Illinois

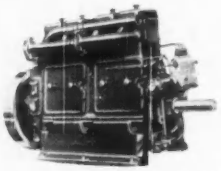
REPRESENTATIVES IN ALL PRINCIPAL CITIES

**"FIRST WE HAD *One*
NOW WE HAVE *Two!*"**

John C. Neilsen, Jr.
Neilsen Ice Cream Co. Port Chester, N. Y.



ENGINE NO. 1. Lister-Blackstone Model S P Horizontal, 50 HP driving 7½ x 7½ ammonia compressor. Installed 1942.



ENGINE NO. 2. Lister-Blackstone Model 38/4, 40 HP driving two ammonia compressors, 6½ x 6½ and 5½ x 5½. Installed 1950.

Yes, LISTER-BLACKSTONE Diesels are catching. Again and again where one goes in, *others follow by invitation!*

Success in producing superb quality ice cream and candy increased the production and power demands of the Neilsen Ice Cream Company. An additional Lister-Blackstone was recently purchased to augment the power of Neilsen's first Lister-Blackstone installed in 1942.

NEW REDUCED PRICES

Best-ever value, lowest cost per horsepower NOW. 3 to 300 HP. Write us your requirements. Address Dept. T.

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For Diesels — Since 1910 . . .**

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CRANKSHAFTS - CONNECTING RODS
MACHINE FORGINGS
ELLWOOD CITY, PENNA.

GE Appointment

J. Russell Watt has been appointed sales manager of industrial laminates and insulating materials for the Chemical Department of the General Electric Company with headquarters at Coshocton, Ohio.

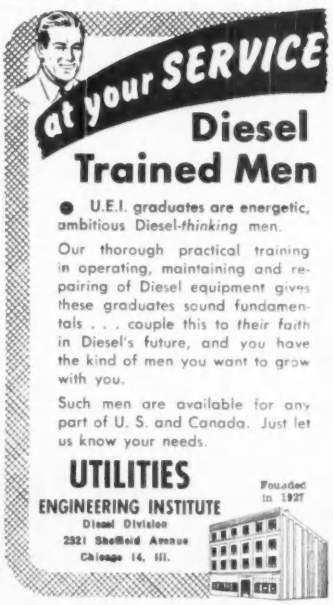
Born in New York City, Mr. Watt has been living in Avon Lake, Ohio—a suburb of Cleveland, where he was sales representative of the Chemical Department.

Mr. Watt was graduated from Colgate University in 1938 and from graduation until 1942 was with the Borden Sales Company in Syracuse, New York. He joined the General Electric Company as a priority clerk in September 1942 and was appointed sales representative of the Chemical Department in January 1946.

De Laval Turbine Promotions

Several executive promotions have been announced by the De Laval Steam Turbine Company. James P. Stewart, vice-president and manager of commercial sales division, has been elected Executive Vice President. He will continue as manager of the Commercial Sales Division.

Mr. Reynolds joined De Laval in IMO-De Laval Separator Products Division, has been appointed assistant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● U.E.I. graduates are energetic, ambitious Diesel-*thinking* men.
Our thorough practical training in operating, maintaining and repairing of Diesel equipment gives these graduates sound fundamentals . . . couple this to *their faith* in Diesel's future, and you have the kind of men you want to grow with you.
Such men are available for any part of U. S. and Canada. Just let us know your needs.
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Founded in 1927

COMPACT *Series "K" Roper Pumps*

EASY TO INSTALL AND APPLY ON A WIDE RANGE OF JOBS

Yes, you can save space and reduce power costs with Roper Series "K" Pumps. They are very compact in design, yet sturdy enough to handle a wide range of jobs . . . pressure lubrication, hydraulic service, fuel supply, or transfer work pumping clean liquids at capacities up to 50 g.p.m.

They are self-lubricated by the liquid pumped . . . handle total suction lifts up to 25 feet . . . come equipped with mechanical seal or packed box . . . with or without relief valve.

Series "K" pumps are available in ¾ to 50 g.p.m. sizes, pressures to 150 p.s.i.

ROPER *Rotary Pumps*

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GEO. D. ROPER CORP.
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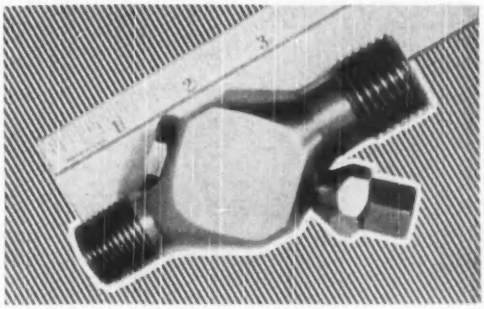
KIENE®
DIESEL INDICATOR VALVES



KIENE VALVES are designed to give good service under most severe conditions. WILL NOT BLOW OPEN, as valve opens against pressure. The KIENE VALVE HAS EFFECTIVE GAS SEAL when opened or closed, without use of packing or glands.

The KIENE VALVE is SMALL AND RUGGED, 4¼" in length and requiring only 3½" circle of space for attachment. Has been operated at pressures up to 10,000 psi.

ALL KIENE VALVES have standard indicator plug and wing nut connection. Regularly furnished with male ½" NPT engine connection. Other threads furnished on order. Special adaptions for most Diesel locomotive engines.

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GENERAL MOTORS
DIESEL POWER

GENUINE FACTORY PARTS KEEP YOUR OLD ENGINE UP TO DATE

PARTS

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IN CYLINDER LINERS
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ARE A "MUST" IF YOU WANT
TO KEEP YOUR ENGINE
"IN THE PINK"

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DIESEL ENGINES

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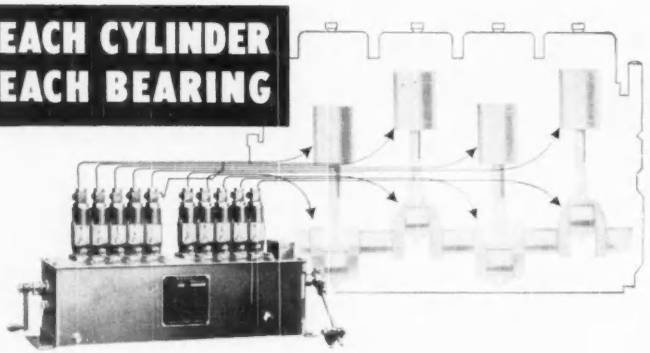

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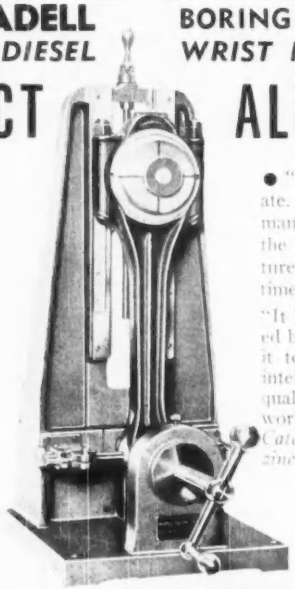

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to the president, and W. A. Neumann, Jr., controller of the company, has been appointed acting manager of the IMO-De Laval Products Division, but will retain the title of controller. He was appointed controller in January 1949.

Mr. Stewart has been associated with De Laval since 1946. He came to the firm after 17 years with the Elliott Company. He is a graduate mechanical engineer (Cornell University) and is a member of the ASME, SAE, and an associate member of the Society of Naval Architects and Marine Engineers and the American Society of Naval Engineers.

Mr. Reynolds joined De Laval in 1932 when he was made manager of the IMO Pump Division. A graduate of Yale Sheffield Scientific School, he is a member of the Society of Naval Architects and Marine Engineers, the United States Naval Institute, and the American Society of Naval Engineers.

Mr. Neumann has been associated with the company since 1946 when he was appointed Assistant Factory Controller. Prior to his association with the firm, he had been employed by Westinghouse. He is a mechanical engineering graduate of Michigan and also holds a Master's Degree in Business Administration. He is a member of the Controllers Institute of America, National Association of Cost Accountants, Accounting Council of Machinery and Allied Products Institute, and Accounting Task Committee Chairman of National Security Industrial Association.

Valve Division Director

James H. Binger has been elected vice president and general manager of the Belfield Valve division of Minneapolis-Honeywell Regulator Company, it was announced by Harold W. Sweatt, president.

Binger will be in charge of manufacturing and engineering in the valve division, as well as coordination of the sale of valves through the Brown Instruments and other divisions of the company, Sweatt said.

A native of St. Paul and a 1941 graduate of the University of Minnesota law school, Binger joined Honeywell in 1943 as administrative assistant

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in the aeronautical division, and in December of 1945 was elected assistant secretary of the company. Two years later he was made assistant vice-president and was transferred to the sales department, a position he held until his latest promotion.

SAE Diesel Officer

A. H. Fox of Standard Oil Company (Indiana) has been elected vice president of the Society of Automotive Engineers, representing the Diesel Engine Activity of that organization for 1950. In Standard's research department he is group leader in charge of the work on diesel fuel applications.

Mr. Fox was graduated from Purdue University in 1928 with the degree of bachelor of science in mechanical engineering. He was employed by the Texas Company (China), Ltd., as an engineer from 1928 to 1936, and travelled extensively in the industrial centers of northern China. He was located in the Mukden office at the time the Japanese took over Manchuria, and was later moved to China proper.

Mr. Fox obtained his master's degree from Purdue in 1937 and joined the research department of the Standard Oil Company (Indiana) the same year.

Gulf Oil Appointment

W. B. Shirk has been made director of Industrial Products Engineering in the newly-formed Product Development and Product Engineering section of Gulf Oil Corporation. The announcement was made by H. P. Hobart, vice-president.

Mr. Shirk is an electrical engineering graduate of Lehigh University, '20. He received his early education in Lebanon, Pa., grade and high schools.

After some years with Bethlehem Steel Corp. and the Westinghouse Electric Corp., he joined the Gulf organization as a lubricant engineer in 1932. He has recently been serving as Chief Industrial Lubrication Engineer in lubricating sales.

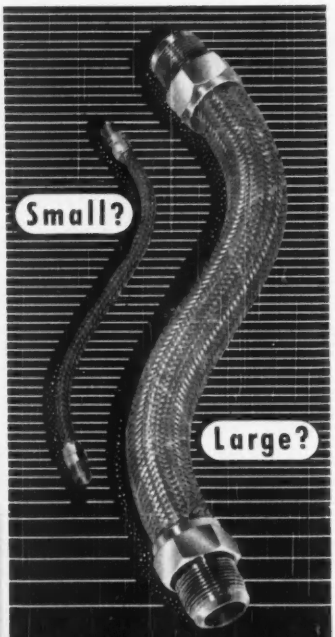
His new appointment places Mr. Shirk in supervision of the application of fuels and lubricants to prime movers and industrial plants. His staff will include Chief Fuel and Lubricant Engineers G. B. Burkhalter, (Railroad & Marine Section); R. W. Van Sant, Jr., (Diesel Engine Section); C. F. Kottcamp, (Turbine and Steam Power Section); R. L. Wheeler, (General Machinery Section); R. A. Fitch, (Metallurgical Section); R. L. Grun, (Process Oil Section); J. P. Critchlow, (Rolling Mill Section); W. S. Miller, (Paper Mill Section); K. P. Powers, (Textile Section); and H. M. McCain, (Mining Section).

Obituaries

Alan E. Ashcraft

Alan E. Ashcraft, for many years a Director and Vice President in charge of manufacturing of Fairbanks, Morse & Co., Chicago manufacturers, died in January at his home in Kenilworth, Illinois.

Mr. Ashcraft, following his graduation from the Cornell University with the degree of Mechanical Engineer,



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joined the Fairbanks-Morse organization in 1903. He became Manager of the Beloit Pump Works, and in 1916 he was transferred to the E. & T. Fairbanks Co. at St. Johnsbury, Vermont, where he was Factory Superintendent and later Vice President and General Manager of that plant. He was located in St. Johnsbury from 1916 to 1932. In 1932 he became Works Manager of the Beloit Factory, which position he held until 1936.

At that time he was transferred to the Chicago headquarters office of the company as Vice President in charge of manufacturing. In 1942 he became a Director of the company, as well as Vice President, which position he held until 1946 when he was retired after being with the company for 44 years.

Julie Schoder

The death of Miss Julie Schoder, treasurer of Lanova Corporation, has been a severe loss to the firm. Miss Schoder was appointed treasurer of the firm in 1948 and had been associated with Lanova since 1934.

Born in Augsburg, Germany, Miss Schoder was educated at the Augsburg Private Institute of the Order of the English Ladies. She was graduated with highest honors from the institute. Upon graduation, Miss Schoder became the private tutor to the children of the Countess von Salm, which position she left to join the staff of Maschinenfabrik Augsburg-Nurnberg, German engine manufacturers.

Tank Contents At A Glance

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In 1927, Miss Schoder came to this country as treasurer of the American division of Mosse Verlag of Berlin. She remained in that capacity until 1934 when she joined Lanova Corporation. In 1945, Miss Schoder was appointed Secretary of the firm and was made treasurer in 1948.

Sidney B. Cooper

Sidney Bruce Cooper, Transportation Engineer for the Westinghouse Electric Corporation, died on January 20 after an illness of six weeks. Surviving him are his wife, Mrs. S. B. Cooper; two daughters, Mrs. R. E.

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Swan, Oakmont, Pa., and Mrs. James Hepburn, Pittsburgh, Pa.; and a son, Mr. Charles Cooper, San Francisco, California.

Born and reared in San Francisco, Calif., Mr. Cooper graduated from the University of California in 1910 with a Bachelor of Science degree in Electrical Engineering. He joined Westinghouse the same year and upon completion of the graduate student training course was assigned to electric transportation activities. He followed this work until his recent illness.

During his career, Mr. Cooper traveled extensively throughout North America, South America, and Europe. He served Westinghouse in various engineering, management, and consulting capacities. He was recognized as an authority throughout the electric transportation industry and wrote many technical articles and delivered numerous papers before national engineering societies.

Harry S. Smith

Harry S. Smith, Vice-President of Burgess-Norton Mfg. Co. died early this year. Mr. Smith had been associated with the Burgess-Norton Mfg. Co. for 19 years. Mr. Smith had been ill since October 9, 1949. He leaves a widow, Florence C., a son, H. Morgan and a daughter, Mrs. Ruth Hutchinson.

Mr. Smith was active in Manufacturing, Government and Farm Equipment sales. He had been an officer of the American Washing Machine Manufacturers' Auxiliary and was a member of the Union League Club, Society of Automotive Engineers, and Farm Equipment Institute, and a Life Member of The American Ordnance Association.

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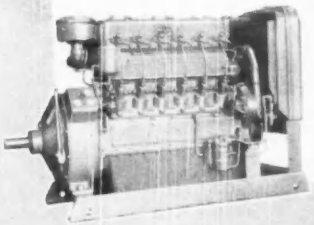

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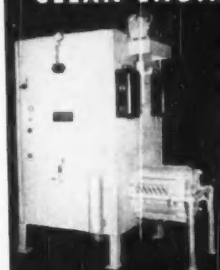

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When a large midwestern manufacturer needed a medium for absorbing both lateral and axial movement in a hot gas line, his immediate choice was Zallea Stainless Steel Flexible Connectors—for assurance of dependable performance. Pictured here is one of a group of 24" diameter Zallea connectors installed in the plant.

Made expressly for use on Diesel exhausts, high temperature air and gas lines, and like applications, these Zallea Flexible Connectors are hydraulically formed from a cylinder having a single longitudinal weld, insuring maximum durability and long trouble-free service

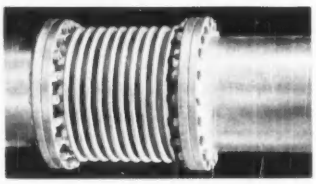

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Figure 8 Flexible Connectors are designed to absorb ¼" axial movement (5" diameter and smaller $^{3}/_{16}$") per corrugation up to a maximum of ½" traverse with open pitch corrugations and up to a maximum of 3" traverse with close pitch corrugations. Figure 15 Flexible Connectors are designed to absorb .083" axial movement per corrugation up to a maximum of ½" traverse with open pitch corrugations and up to a maximum of 2" traverse with close pitch corrugations.

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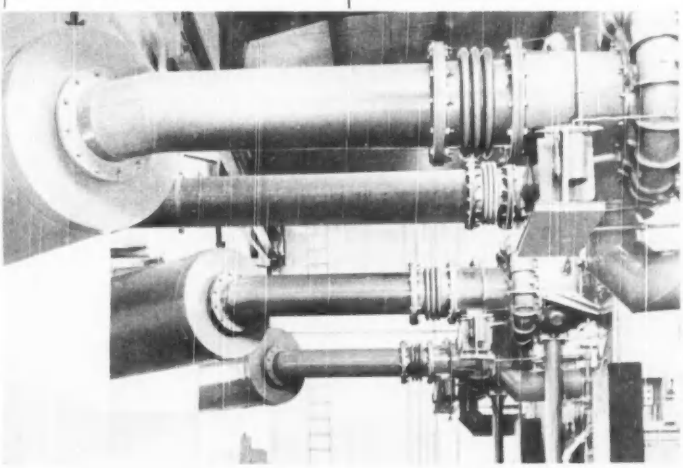

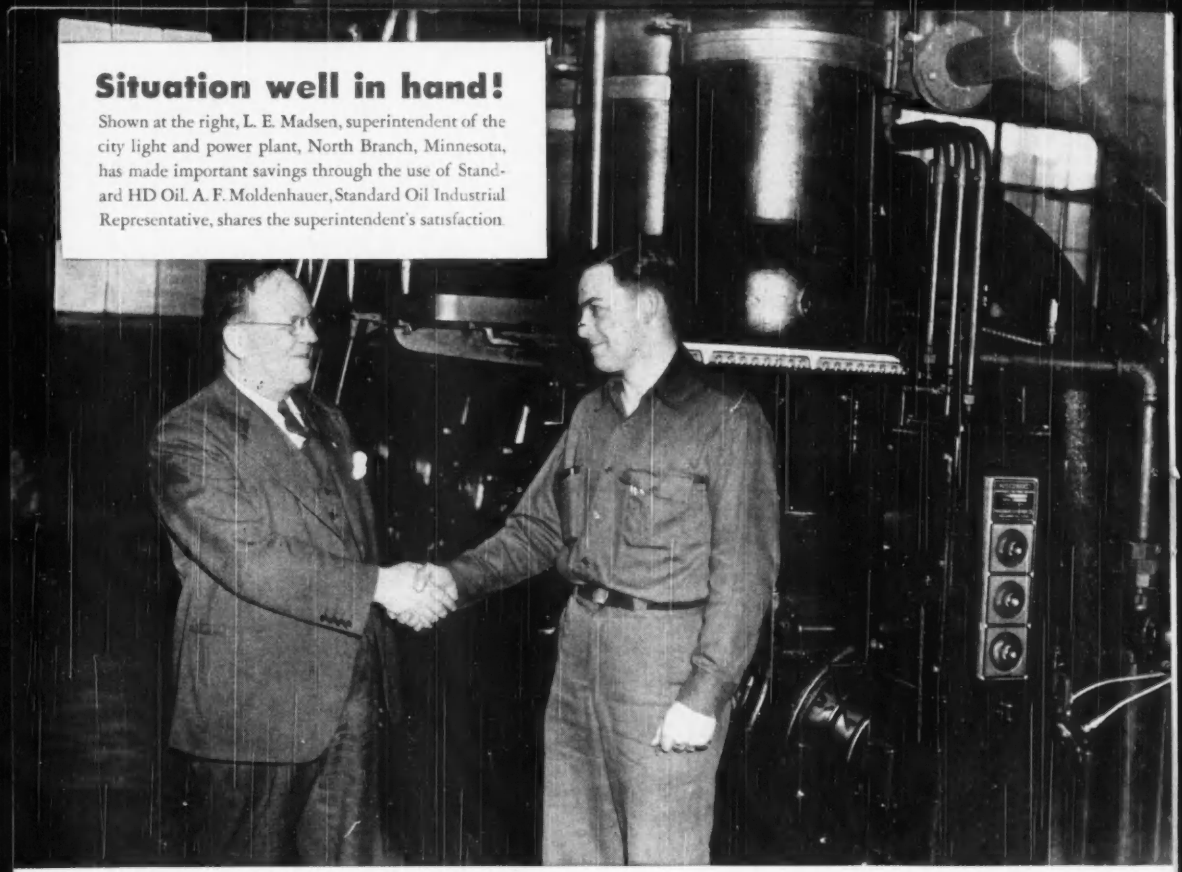

Situation well in hand!

Shown at the right, L. E. Madsen, superintendent of the city light and power plant, North Branch, Minnesota, has made important savings through the use of Standard HD Oil. A. F. Moldenhauer, Standard Oil Industrial Representative, shares the superintendent's satisfaction.

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